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ON

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Working Papers of the Four Subpanels

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This document is the supplement to the Defense Science Board 1982 Summer Study on Training and Technology. It presents a compilation of the problem analyses and discussions as written by the four subpanels during their deliberations at Colorado Springs.

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PREFACE

This document is the supplement to the Defense Science Board 1982 Summer Study on Training and Training Technology. It presents a compilation of the problem analyses and discussions as written by the four subpanels during their deliberations at Colorado Springs.

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OPERATIONAL TRAINING

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OPERATIONAL TRAINING

A. STATUS AND OVERVIEW

Operational training is defined as that training undertaken in the units of the field commands and fleets -- or, said another way, that training conducted outside of the schoolhouse. The end product of the training system must be proficient operational units that can go to war and win at least cost.

Operational units conduct both individual skill training and collective (team) training at all levels of the organizational hierarchy, from crew and squad training to fleets and carrier battle groups, air forces and wings, corps and divisions. While it is well understood that practically all collective training must be performed within units, it is easy to forget that much individual training also must be conducted in units. This consists of refresher training (practice on skills taught initially in the schoolhouse); on-the-job (OJT -- training within a unit which qualifies an individual in a military occupational specialty); or "train-up" (an advancement in skill level within military operational specialty).

The performance of individual training within units can be a healthy thing. Individual training can be used to fill what would otherwise be non-productive gaps between collective activities. The key trainers within units are noncommissioned officers and, in some cases, officers. Junior leaders grow in capability and stature through preparing and conducting training for the troops they lead. There are also important team-building and cohesive effects that flow from the delivery of effective instruction by team leaders. But, the individual skill training load of units must be in balance with unit capabilities. That is, there must be a sufficient number of trained petty officers and sergeants, effective training support material, adequate time, and a relatively stable environment for units to do both individual and collective training well. Often, many of these essential resources are not present.

The panel gave great attention to the question of the proficiency of our forces. We found that there is clear and persuasive evidence that our units are not good enough. Deficiencies in maintenance and operator skill proficiency are widespread. Commanders and their battle and logistics staffs do not get enough practice. The stress created by undermanning, personnel turbulence, heavy operational commitments, and the introduction of new weapons is too great for units to approach the training efficiency necessary to develop the design capability of our weapons systems. How do we know this is true? Senior commanders have told us so. Service training evaluations forthrightly point our Service deficiencies. We know about the Joint Staffs Remedial Action Program (RAP) which lists hundreds of serious training deficiencies uncovered in joint and combined exercises.

We have seen GAO and Service Audits that confirmed numerous training deficiencies. And, the DSB 1981 Summer Study on Operational Readiness with High Performance Systems highlighted the training problem. In summary, we find a substantial proficiency gap between where our units are today and where they should be. If we must be prepared to fight outnumbered and win and we are without a decisive qualitative edge in equipment, it is clear the training proficiency will be the discriminator. Training gives us the greatest leverage in improving our forces quickly.

While we insist there is a serious training gap, the panel wants to make clear that this is not for lack of effort by the Service members working the training problem. These may be the best trained peacetime forces we have ever had -- we cannot judge this accurately. But the question is irrelevant. No matter how our forces compare with those of the past, they are clearly not good enough for today's world. And the key point is that our forces cannot make the necessary qualitative jump just by working harder with traditional training methods and tools. We need to give our units some powerful training tools -- technology must be harnessed. The issue and recommendations that follow tell what this panel believes should be done to augment current training activities.

1. Leader Training

Operational training for leaders -- for commanders and their staffs at both senior (e.g., Joint Task Force, Navy Battle Group, Army Division) and junior (e.g., battalion, squadron) levels -- is inadequate. This may result in a significant deficiency in command and control capabilities in crisis management and combat. Any effort to provide more training for them in conjunction with live operations would interfere with other training objectives, and would entail major expenditures to increase the tempo of operations, and the complexity and realism of field exercises.

Training resources (operating time, ordnance, range access, etc.) are necessarily devoted primarily to unit training, which must be conducted at relatively basic levels because of the effects of personnel turbulence. As a result, there are not enough live operations of a scale and complexity suitable for command training, especially at senior levels. Furthermore, available physical threat simulation is inadequate in performance and scale to pose realistic problems for command training at more junior levels. All of the Services have excellent threat simulators, but not in the quantities required to support the full range of live operations. Moreover, there is a distinct need for more and better training exercises for combat support.

Command and staff training does not always require reproducing the physical phenomena of force generation, deployment, combat, and combat support. These can be simulated quite effectively and inexpensively for the purpose as long as the emphasis is on the operational and logistic problems to be solved by the commander, rather than on reproducing real-world displays, physical environments, etc.

The panel considers that the gap in command and staff training and readiness can be substantially closed by the appropriate application -- in line with the specified emphasis on realistic presentation of the problem rather than the physical environment -- of readily available technology and simulation techniques. Two types of simulation are required. They must be readily transportable, or at least accessible (by telecommunications) from the normal locations of the commands that might use them:

a. Single-node - i.e., one commander, with or without staff -- campaign, battle and engagement simulations. In these, the simulation system, possibly augmented by an "opposition force controller," would pose the operational problem, and simulate both the execution of the commander's decisions and the response of the environment -- friendly, and hostile -- to them.

b. Interactive war games for team training, both within a single headquarters and among several commands. In these, the system would simulate the execution of commanders' decisions, provide information regarding outcomes and the actions of other force elements, and allow realistic communications among commands and staff elements.

All the Services have -- and are continuing to develop -- gaming and simulation systems intended to support commanders in the field, in addition to institutional users such as the war colleges. Considerable amounts of money are earmarked for these systems. Less attention has been paid to the development of appropriate problems, scenarios, etc. Operational commanders have in a number of instances undertaken to get needed work of this type done, using unprogrammed funds from various sources. The focus on operational realism clearly implies that the development of these simulations and war games must be directly responsive to the major operational commanders, irrespective of how the individual Services choose to assign the development responsibility. Based on recent experience with such simulation, funding in the amount of $15M a year should be provided for the purpose over the next five years. Development lead-time is known to be relatively short. The use of much command-oriented games and simulations promises quick returns in improved command and staff training -- and therefore in operational effectiveness.

Unit Training

In addition to leader training, just discussed, there is additional help needed for our units. The Services have been slow to adapt simulators, part-task trainers, and organic training programs (both standalone and embedded) to unit training tasks. One reason seems to be the fear of commanders that their traditional training resources will be dried up before new methods are installed, wrung out, and proven effective. Past programming actions in Washington may have justified this fear. We must remember the objective: to close the training gap.

Premature talk of substituting simulators for flying hours, steaming hours and battalion training days is counterproductive. In the judgement of Service Leaders who briefed us, they were short several hundred millions of dollars of needed operation and maintenance money to produce necessary unit training. We know that training funds were cut as a part of the Service and OSD programming and budgeting process in competition with end-items and structure. But, with the high leverage that good training has on unit proficiency, dollars (procurement and O&M) should fully support training.

There is never enough money to go around -- but the need for good training is even more important when end-items, force structure, or other support is short. One can argue that the more forces are constrained, the more important training becomes, to insure that full design capability is obtained from the equipment we have. In addition to doing more of the things we already know how to do well, something new must be added -- the training system must be given more power.

Unit trainers must harness technology. The capabilities of the microprocessor and interactive video disk have many applications to improve training while reducing the need for expensive end items such as maintenance and operational training aids. Ideally, the Service schoolhouse [illegible] develop the specific applications and hand them off to operational units when they meet unit requirements for portability, flexibility and efficiency. Field training devices must work within the power, transportation, and storage capabilities of the units.

Training aids need not be complex or expensive. The lowly chalkboard and field-expedient sand table are perfectly suited for many training situations. The key is good task analysis and proper performance criteria. From these, the trainer can determine the sort of aids he needs. The utility of conduct of fire trainers and interactive devices to track maintenance tasks has been demonstrated. The Services need now to develop programs to systematically introduce such devices into the full training system, from schoolhouse to unit.

The Services are using some field engagement simulation with good effect. The introduction of the Multiple Integrated Laser Engagement System (MILES) seems to generate genuine enthusiasm in the Army and Marines. But until indirect fire simulation (mortars, artillery, helicopters, close air support) is added and dirty battlefield realism is improved, even MILES (good as it is) will have its greatest effectiveness limited to teaching the platoon and company team.

The Air Force RED FLAG exercises use simulation effectively but the range does not realistically simulate the full density of air defense systems the threat would field.

The Navy should develop engagement simulation. The benefit to be derived from RED FLAG-type operational training for the Navy is considered to be of the highest priority.

Currently, Navy air-to-air training employs the "Top Gun" training unit at NAS Miramar, which has proven to be excellent in providing fleet pilots with realistic training. "Top Gun," however, is very limited in its capability to provide training for large numbers; thus, not every fighter pilot is afforded the opportunity to receive the benefits of this valuable training.

It seems logical, based upon the excellent results of RED FLAG and "Top Gun," that the Navy develop an "O" range (enemy) force discipline which would encompass 'll opposing force assets (some owned and some borrowed) during fleet operational training. Currently, "Top Gun," Fleet Electronic Warfare Service Group (FEWSG), Mobile

Sea Range Team, and the designated Com Orange are all in different commands, with no cohesive element bringing them together. Com Orange should be immersed in all the tactics, weapons capabilities and the assets necessary to apply realistic opposition to the fleet, with "no holds barred" except those that would involve safety.

3. Joint Training

The current joint and combined exercise program consists of a cyclical series of theater-specific exercises of the CINCs and three JCS-sponsored exercises annually. These are excellent training for the participating headquarters, and to exercise deployment systems and the transportation agencies. But they are very costly -- about $250M per year for transportation alone. Even so, our tactical commanders and staffs need much more training. And we must get this training without the cost of moving ships, planes and troops as training aids. Joint battle simulations and war games are the answer. Training technology can help (a) by teaching detailed technical information (e.g., computer-aided instruction, TV presentations) and (b) by imparting skills in information assessment, decisions on asset assignment, and communications. The last can be done by one- or two-sided computer actual combat systems, or common pool hardware through digital signal processing techniques.

All joint exercises are concluded with a critique and afteraction report that identifies problems and lessons learned. These are catalogued in the Remedial Action Plan (RAP) of the Joint Staff. Unfortunately, little seems to be done to solve the problems systematically or to insure that in following year's exercises new players will not repeat those mistakes. These problems must be corrected; someone must be put in charge; and there must be follow-up to insure problems stay solved.

The Service operational commands should seek energetic ways to include participation from one or more of the other Services when they schedule unilateral field training exercises. Some of this is done today. During brigade field exercises, USAF Tactical Air Control parties join Army units in the field and, often, live sorties are flown in support. But the panel believes more could be done involving the Navy and Marines with the other Services during field exercises.

a. <u>Role of the JCS</u>

The JCS is charged with training of the joint forces. Title 10 U.S. Code, Sections 141-143 provide the Chairman with that authority. However, funds available for joint exercises are limited and consumed by joint exercise transportation costs ($244M of $365M in FY83). As a consequence, the interrelations and connectors required of joint force coordination are inadequately exercised, or do not exist. While each member of the Joint Chiefs is sensitive to the need for joint training, and unified commanders have stated as objectives the goal of building and exercising the "connectors" of the joint forces, the JCS needs alternative mechanisms for meaningful joint force training.

One may argue that joint forces will be orchestrated as circumstances require. Israeli forces, for example, were formed together by fear during 1973. The Israelis, after winning in 1967, fashioned an unbalanced force of tanks and aircraft, i.e., they "reinforced success" by buying tank and aircraft at the expense of artillery and ground troops. Unfortunately, their tank-heavy forces met a profusion of Arab ATGMs. Israeli aircraft were restricted by Arab air defense systems. The notion of restyling the forces under the pressure of battle is dangerous. The Israelis were lucky. The lesson should not be lost on our JCS: to structure a joint force by reacting to prevailing conditions is always risky, but to send that force to war untrained is unthinkable.

Since joint training is the Joint Chiefs' responsibility, alternatives for training most assuredly should be of interest to the Chairman. What, for example, are the Chiefs' abilities to accept change as new and modern equipments are introduced into the joint force. Force readiness usually declines shortly after IOC of new systems, until the troops learn how to integrate the systems. The abundance of new equipment IOCs could soon create severe joint force training and readiness problems if these introductions are not well provided for. One could argue, therefore, for transfusions of large amounts of monies for joint training -- monies unlikely to be made available. The Secretary of Defense must have the Joint Chiefs' views of the following:

- Can we effectively integrate the proposed new systems in the joint force without reducing overall force readiness?

- What plans do the Joint Chiefs have to anticipate changes in training techniques required by the "new" joint forces?

The notion of supporting the Joint Chiefs with a training technology base to assure a favorable climate capable of providing technical answers to some of the problems in training the joint force has merit. (Why not use DARPA to assist the JCS?)

The present DSB panel on training proposes an OSD Executive Steering Committee to be chaired by the DDR&E and the MRA&L. Members would include the Chairman's designated representative (J5, CINCREDCOM, etc.). Since it is proposed that the Committee provide guidance to DARPA, the mechanism for providing a "corporate" R&D laboratory for the JCS could exist with minimal organizational changes in OSD.

DARPA, for example, should "fence" a portion of their budget to developing technologies that provide the JCS alternatives to joint training exercises -- a series of issues including:

- How to exercise C^2 connectors of the joint force
- How to avoid transportation (flying hour) costs of joint exercises
- How new weapons integration (IOC) will change force readiness

Answers to questions relating to the Joint Force have potentially the highest possible leverage. If high level commands can "debug" operations in peacetime, changes in the "shadow of war" will be reduced.

Inherently, one should conclude that force-on-force combat simulations of the joint force is one important method of overcoming exercise funding shortfalls -- not a substitution for exercises. One could also assert that the more successfully the JCS integrates the joint force the easier it will be to capture a truly representative force-on-force simulation.

The JCS must originate joint training guidance. The JCS-originated Joint Strategic Planning Document (Ten-Year Plan) must carefully articulate joint force training needs and goals. These JCS training technology goals would impact the Service POMs through the Services "Extended Planning Annexes."

b. Ranges

(1) Overview

Following extensive use of simulators for individual, group or force training, there comes a time to "put the rubber to the road," i.e., conduct these exercises with real hardware by real units in an instrumented environment.

Service chiefs, range commanders, and MAJCOM commanders have expressed with great concern the constant erosion of range capabilities by encroachment from other than DoD users (i.e., airways, oil exploration, political pressures, housing, etc.). Additionally, airspace restrictions imposed by FAA (positive control of altitude and geographic boundaries) have inhibited training, particularly undergraduate pilot training.

The introduction of new, long-range weapons (i.e., modern tank guns, over-the-horizon missiles, etc.) have created a demand for expanded sea, land, and airspace which may be difficult to obtain. Further encroachments will negatively impact on the Services' ability to employ new weapons systems, large-scale land battle exercises, EW and opposed training.

Many ranges that have the capability of conducting operational training for the Services are heavily front-loaded with R&D and T&E projects. Operational forces are allocated range time in accordance with assigned priorities which may not meet the operational commanders' requirements.

The most important deficiency of the ranges is their inability to provide adequate threat simulation for operational training. This constraint includes realistic density, latest aggressor equipment, and realistic aggressor C^3 and EW. Through lack of funding, the Services have not been able to develop physical threat simulations for the many systems that represent the real threat to our operating forces.

Even though some excellent simulators exist, including actual enemy hardware, they are not available in sufficient quantity to support operational training to any meaningful degree. The main point is that range and airspace are a most important and essential national resource for the Services. The ranges must be protected.

Conclusion: Strong representation should be made by JCS to OSD and then to Congress: (a) to keep what we have, (b) to expand to meet new weapons capabilities, and (c) to equip adequately to provide the Services with the physical and electronic means to train operational forces to meet and defeat the enemy.

OSD and the Services must take appropriate action to provide the necessary funding to support this important aspect of training. It is estimated that $300 million in FYDP funding will be required to equip our current ranges and to make available for operational training in various locations the realistic physical and electronic threat simulations now lacking. Industry must be assured, however, that there is a market for low-cost threat simulators.

(2) **Range Density**

Ranges for the most part are not located in proximity to a units home base. Therefore, a great deal of travel is necessary and thus time is lost to reach the range prior to mission performance.

Range density, which results from limitations of space, air, sea or ground provides further aggrevation of an already-clogged system. It becomes obvious that if the training range facility were contiguous to the unit, less time would be spent in transit.

It may be propitious to have the Range Commanders Council take this as a study item and perhaps arrange better utilization of each of the Service ranges, rather than travel great distances for weapons system delivery. Conclusion: Range Commanders Council be assigned such study.

4. Training of the National Guard and Reserve Forces

Under the total force concept, contingency plans place more reliance upon early readiness of reserve component units than ever before in our history. There are special training problems for the Army and Air Force, the National Guard and the Reserve units of all four Services. Nearly one million soldiers, sailors, airmen and marines (over two-thirds of these are in the Army) are assigned to selected Reserve units located at home stations throughout the fifty states and several U.S. possessions. They are dispersed among nearly 5,000 National Guard Armories and Reserve Centers. Typically, members of these units drill one weekend a month, with a two-week annual training period -- a total of 38 days. Often, units do not have first-line equipment; frequently their combat vehicles cannot be exercised near their home stations; and many maintenance units will be required to maintain models of equipment upon mobilization which they do not have in peacetime.

The unique situation of Reserve and Guard units needs urgently the help that modern training technology can give. Training devices using video disks and microprocessors should be very useful in providing effective and realistic training, especially in view of the sterile training environment that befalls many reserve units. The courseware and devices should be the standard ones used by active forces. As Reserve and Guard units are mobilized and deployed, their modern training support materials would be available to help meet the training surge of draftees -- a significant bonus effect.

Supplementary data on ranges and related operational training requirements and capabilities are presented in the following section. These data amplify on the problem of range encroachment, full-scale threat simulators and the logistics of range usage.

B. SUPPLEMENTARY DATA

The issue of the air, land and sea encroachment problem and the inadequacy of quality and quantity of EW equipment (physical and electronic) is expanded upon as follows:

1. Air Force

a. Issues

(1) The USAF has faced increasing problems in getting the FAA to be responsive to Air Force airspace requests and proposals.

(2) Can DoD, and specifically the Air Force, continue to operate effectively within the National Airspace System as it is now administered?

b. Background

The Air Force has faced increased problems in developing adequate airspace in which to conduct its training. These problems center around competition for airspace from other users. The FAA also attempts to interpret and enforce DoD goals of IFR to the maximum extent by restricting DoD operations to and from training areas to IFR. In addition, the FAA has not been responsive to the Air Force composite force training program by requiring extensive publicity and charting of temporary special-use airspace well in advance (30-45 days) of the exercise. Most of these exercises are not finalized until 30 days prior.

In addition, increasing demands from other users for additional runways/airports may impact future ability to conduct adequate training. For example, the proposed Apache Junction Airport, nine miles NE of Williams AFB, AZ lies directly in the T-38 radar downwind pattern and directly under the T-38 arrival/departure corridor. Williams AFB, AZ had the second highest near-miss rate with general aviation aircraft of all Air Force bases in 1980 and 1981. Another major airport proposal that will impact Air Force operations is the proposed Palmdale International Airport (PIA) located about ten miles east of Air Force Plant 42 and 15 miles south of the R-2508 complex. The proposed routings out of PIA would impact operations at Plant 42 (require runway closure), George AFB, CA, (put cap on airspace above George AFB), and Edwards AFB by deleting portions of the R2515 complex which includes the Precision Impact Range Area, a multi-million dollar range, and several spin-test areas, as well as deleting one of only eight supersonic test corridors in the US. The FAA appears unresponsive in the several specific areas of airspace management.

1. Military operating areas (MOAs) have been increasingly denied AF use.

    - FAA has not acknowledged AF priority use of MOAs in Letters of Agreement with scheduling units.

    - FAA has denied the AF the prerogative of proceeding VFR to/from MOAs thus reducing MOA use.

    - FAA unilaterally withdrew a UPT MOA with no replacement airspace.

    - ARTCCs have imposed restrictive separation criteria on UPT MOAs thus reducing effective airspace.

    - Reduced radar coverage in UPT MOAs by ASRTCCs.

(2) Military Training Routes (MTRs) were established in 1977 to increase safety and reduce mid-air collision potential.

- MTRs were designed to provide areas for military training at speeds in excess of Federal Aviation Regulation (FAR) airspeeds. DoD granted exemption to FAR for designated routes.

- Confinement to designated IFR or VFR routes restricts training realism.

- IFR routes are not adequately covered by ATC radar.

- FAA has not adequately supported the MTR program through MTR notification to general aviation.

(3) FAA appears to be more responsive to political/economic pressures than DoD requirements. The FAA...

- appears to avoid commitments until political figures state positions.

- forced formation of Florida Airspace Utilization Committee to review military airspace requirements in state.

- manages a complex ATC system designed to accommodate civil traffic and not responsive to military mission.

- is losing its military experienced personnel through retirement.

- asserts DoD is unable to quantify what adequate "National Defense needs" are.

- asserts DoD emphasis on "flight under IFR to maximum extent practicable without unacceptable mission degradation" has worked against us in cases where FAA attempts to define "IFR to maximum extent."

(4) Military Liaison Officer (MLO) reductions.

- Specific FAA individuals were assigned as MLOs at each FAA regional office.

- MLOs provided direct liaison with military units in each region.

- Provided a focal point for military affairs.

- Positions transferred to other duties with MLO an additional duty for someone.

- Elimination of MLO positions provides no focal point for military activity requirements.

(5) FAA pushed for use of Offshore Warning Areas.

- Offshore Warning Areas established for military activity.

- FAA pushed for Severe Weather Avoidance Program (SWAP). SWAP designed to allow use of warning areas by civil air traffic.

(6) Increasing state involvement -- Florida, Michigan, Maine.

(7) Increasing civil aircraft usage.

	1978	1990
(a) General aviation	189,000	291,000
(b) Air carrier	2,300	3,100

(8) Environmental concerns

(a) Public more aware/active
(b) Supersonic aircraft proposals delayed

(9) Other

- Apache Junction Airport - A new general aviation airport is being proposed in proximity to Williams AFB. This new airport will cause significant reroutings of Williams' traffic and will increase the mid-air collision threat. Despite repeated high-level AF opposition, the FAA apparently will approve the airspace proposal.

- Palmdale International Airport - The FAA has announced that this new airport will require the AF to close one runway at Plant 42 and that civil aircraft will transit the Restricted Areas around Edwards. AF is strenuously opposing this airport until AF concerns are resolved.

- The National Airspace Review (NAR) is a total review of US airspace policy and procedures. We expect other user groups and the FAA to use the NAR as a forum to push for further reductions and restrictions on military Special Use Airspace.

- The National Airspace System Plan is a $12 billion, 20-year facilities and equipment modernization plan. Even though it has significant potential cost and operational impacts on DoD, this plan was developed in-house by FAA and never coodinated with DoD.

<u>Conclusion</u>: Create a strong airspace management group within DoD to force the FAA to recognize and deal with DoD problems.

Actions may require DoD to invoke "military necessity" clause of FAA Act of 1958 permitting DoD to proceed without complying with FARs.

In summary, the Air Force is concerned that future airspace training operations will be inhibited by increasing demands for airspace by other users and increasing demands for additional airports. These issues will impact Air Force bases and aircrew training requirements. Therefore it is important to support a range improved program as outlined below:

- Supports DTE, OTE and training
  -- Develops and procures threat radars to test and train against
  -- Develops and procures aids to training such as
    --- ACMI systems
    --- aircrew debriefing systems
    --- "Smokey SAMs"

(2) Approximately $100M/year in FYDP

(3) Threat radar systems development and procurement

  -- need to develop new threat radars to meet the current threat
  -- Solution:
    --- add $5M/year to develop threat radar systems for DTE and OTE
    --- add $20M/year for procurement of threat radar systems to train TAF and SAC aircrews

(4) The Defense Science Board expressed an interest in more information on the Onboard Electronic Warfare System (OBEWS or Phantom Range) and the aircrew debriefing programs:

- OBEWS
  -- lights up the RWR when the aircraft flies near preprogrammed threat radar locations and eliminates the threat indication if appropriate countermeasures/evasive actions are taken (uses GPS, digitized terrain)

(5) Funds requested for this program must be approximately $100 milion per year through FYDP

- Last minute cuts to this program may preclude buying at optimum production rates or may delay desired program starts

  -- Underfunding could reduce R&D for threat simulators, procurement portion of Aircrew Debriefing Systems intelligence update for threat simulators, and ACMI pod procurement

(6) Electronic Warfare Aircrew Training System

- Onboard system for aircrew EW training

- Has high priority for funding within range improvement program

- Funding profile (millions)

83	84	85	86	87	88	89
0.5	4.8	7.5	7.0	36.0	36.0	36.0

(7) Aircrew Debriefing System

- Has high priority for funding within range improvement program

- Through FY 84, $10.0 million programmed for instrumentation at Nellis

(8) Threat simulators

- In past, development was limited primarily by lack of intelligence

- Intelligence on new Soviet threat systems has increased considerably

- Funds should be reprogrammed for development of threat simulators, primarily for developing one-of-a-kind, high-quality simulators (i.e., AFSC is underfunding this part of program)

- Provide real time, comprehensive debriefing capability for RED FLAG aircrews

- High priority program in HQ TAC and TFWC

- Now directed at TFWC with technology spinoff to other ranges (KOTAR, Crow Valley, AAC)

- $10M is programmed through FY 83 -- another $10M in FY 84-89 (TFWC only)

- Primary problem is funding cuts causing perturbations in the program, inefficient production rates, and fewer systems in the field

- Additional funding is required for threat radar development and procurement to update the Soviet battlefield threat array and to continue our aircrew debriefing improvements

d. Impact Statement for Funding Cuts for the Range Improvement Program (PE 27429/64735)

Further funding cuts in FY 84 or FY 85 will have severe impacts on the quality of aircrew training.

- Cuts in FY 84 will delay

-- ($2.0M) improvements in aircrew debriefing systems at Nellis Range and ranges in PACAF and AAC

-- ($1.0M) encryption of ACMI transmissions

-- ($1.5M) communication facilities to tie together UTTR, Nellis, and Edwards AFB ranges

-- ($2.0M) threat radar calibration improvements

- Cuts in FY 85 will delay

-- ($6.0M) delay completion of a range control facility at Tyndall AFB; this results in continued use of an inefficient manual testing and tracking system; additional manpower is required to operate this system

-- ($8.0M) delay procurement of a priority threat radar

- Summary: reduction in funds for this program will delay fielding threat radars and will reduce the training feedback to our aircrews.

2. NAVY

a. Issues

(1) Range resources, facilities, and simulators are insufficient for realistic training.

(2) Electronic warfare ranges are not up to the level of threat replication desired for both air and surface warfare training

(3) There is a sizable range encroachment problem.

- Switzerland Bombing Target, FL, Kauna Point, HI, and Culebra Island, PR were all closed as the result of political or local pressure.

- Vieques Island is still the center of court cases related to Navy compliance with various environmental laws.

- Kahoolawe Island was designated a National Historic site. Navy made many concessions to continue the use.

- Pinecastle Bombing Complex, FL, air operations have been restricted by addition to wilderness areas and increased commercial air traffic. More wilderness areas are proposed. Political pressure to get the Navy to move still exists.

- Fallon Nevada is threatened by expansion of geothermal operations and proposed wilderness areas.

- All California and Nevada ranges are threatened by the provisions of the Mineral Mining Act that could open all Federal Land to commercial drilling. For example: El Centro has already received 152 requests to lease lands under their control. DoD and Navy policy on lease approval is being formulated.

- Kaula Rock, HI is currently being studied jointly by DoN and DoI to determine impact of bombing on bird habitats.

- Off-shore drilling currently restricts weapons testing and training at PMTC. Expansion of oil drilling has potential to further encroach on all coastal overwater training areas, forcing us further to sea and fouling the ranges with increased air and ship traffic.

b. Background

In view of the encroachment problem, the Navy has developed a Mobile Sea Range (MSR) which provides the fleet commanders with a vehicle that can produce a quantum leap in fleet readiness.

As can be seen from the MSR presentation, the MSR provides the fleet commander with the capability to take a Battle Group, or smaller units, to sea, and to conduct a live firing missile exercise in a full 360 degree threat environment. Therefore, the restrictions on chaff, electronic jamming and live missile firing, including line firing by Combat Air Patrol (CAP) is fully exercised without constraint, except that imposed by the fleet commander. Our Orange Force (enemy) can employ its full "bag of dirty tricks" and Blue Force (friendly) may counter through the most realistic wartime posture. Safety is paramount.

The MSR is a four-phased program:

PHASE I - AAW (primarily surface ships)

PHASE II - AAW -- With introduction of the aircraft carrier and CAP.

PHASE III - Introduces submarine into the scenario.

PHASE IV - Adds a Mobile Tracking Range for working the ASW problem.

Phases I and II exist. A Data Collection System (DCS) has been developed to collect all sensor data for a real time readout. Communications Tracking System (CTS) has been developed which identifies all of the players.

(1) Relative and approximate priorities are indicated by position on the matrix. That is, resources (listed across the top of the matrix) are prioritized from left (higher) to right (lower); functional training levels (listed to the left of the matrix), from top (higher) to bottom (lower).

(2) Asterisked resources (NCO Training, Drills, Small Unit Tests, and ARTEPS) require funds but even more importantly require people (training developers, instructors) who are the subject of a separate (TRADOC Baseline) study initiative.

(3) Most of the listed resources are discrete, but some overlap. Best example is RC Training which has a separate column but is also resourced under most of the other listed resources.

(4) The large unfunded ammunition requirement assumes that training devices recommended by the Standards in Training Commission (STRAC) will not be fielded. When those devices are fielded, total ammunition requirements will be reduced.

TABLE A-1

MODERNIZATION OF ARMY TRAINING
(IN MILLIONS OF DOLLARS)

FUNCTIONAL TRAINING LEVEL	RESOURCES																
	NCO TRAINING	DEVICES	TACTICAL ENGAGE SIMULATION	BATTLE SIMULATIONS	TRAINING RESEARCH	DRILLS*	SMALL* UNIT TESTS	ARTEPS	LTA/ GARRISON TNG. UPGRADED	TARGETS	RC TNG.	AMMUNITION	MOBILIZATION TRAINING	CONTRACT	REGION TRAINING CENTERS	NATION TRAINING CENTER	GRAND TOTAL
COY/BN AND BELOW	X																
INDIV	X	X	X	X	X	X			X	X	X	X		X	X		
DRILLS		X	X	X	X	X	X	X	X	X	X			X	X		
WEAPONS		X	X	X	X	X	X	X	X	X	X	X		X	X		
UNIT TNG		X	X	X	X	X	X	X	X	X	X	X			X		
SYSTEMS TNG			X	X	X			X		X	X	X					
BN TASK FORCE	X																
CDR DEV				X				X	X	X	X	X			X		
BATTLE STAFF				X				X	X		X				X		
SURVIVABILITY				X				X	X						X		
SYSTEMS			X	X				X	X						X		
INSTITUTION																	
SKILL LEVEL 1		X								X	X	X	X	X			
SKILL LEVEL 2-5	X	X		X						X	X	X	X	X			
OFFICERS				X						X	X	X	X	X			
FY 83 (UNFUNDED)	90	220	0	14	15	2	2	17	0	9	72	541	61	2	0	2	1047
FY 83 (FUNDED)	50	250	58	1	16	0	0	7	20	6	367	758	3	75	0	106	1717
POM TOTAL (UNFUNDED)	1000	750	254	180	62	10	11	81	77	232	513	4985	831	110	212	127	9455
POM TOTAL (FUNDED)	725	1400	215	24	110	0	0	7	50	241	2615	9199	69	450	241	676	16222
TOTAL UNFUNDED	1090	970	254	194	77	2	2	98	77	241	585	5526	892	112	212	129	10401
TOTAL FUNDED	775	1650	273	25	126	10	11	14	70	247	2882	10157	72	525	241	782	17860

c. Conclusions

The following are examples of Army procurements to improve and modernize its training.

DEVICES: COLT for M60A3 and Reserves, Vucean Training System, STINGER Launch Simulator, more flight simulators sooner, tactical SIGNET/EW trainers

AMMO: (Training Practice Ammo) -- low cost Indirect Fire Training Rounds, plastic and limited range ammo, and 105mm armor-piercing, fin-stabilized discarding SABOT (APFDS).

TARGETS: Helicopter threat targets, aerial targets, thermal targets, bas-relief targets

GARRISON/LTAs: Multi-purpose scaled ranges (1/10 scale)

REGIONAL TRAINING CENTERS (RTCs): Multipurpose range complexes (MPRC), limited instrumentation, 1/5th-scale, live-fire ranges, batallion field cantonment areas

NTC: MILES enhancement, indirect fire simulations

BATTLE SIMULATION: MACE and more ARTBASS

DRILLS: Training developers to develop drills

ARTEPS: More training developers to write ARTEPS

PLATOON TESTS: More training developers and printing costs, also MILES usage

TACTICAL ENGAGEMENT SIMULATION: MILES for RC

NCO SCHOOLS: Mostly people, some video disc resources, some mobile training teams, and some MCA (facilities)

MOBILIZATION: Equipment, clothing, weapons and planning resources for the Mobilization Training Base

C. SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS

1. Technology Opportunities to Support Operational Training

- Battle Simulations

  - Chemical Warfare, Electronic Warfare
  - Joint Exercises (Intelligence)
  - Leader and Staff Training
  - Multi-ship Training

- Systems Simulations

  - Full mission simulations, ACFT, Ship Systems (AAW, ASW, ASUW, EW), Tank crews, Indirect Fire, Thermal Sights

- Organic Training (These can be embedded or stand-alone)

  - Design in Surface ships, submarines, aircraft, tanks, and artillery; All computers used for signal processing, target motion analysis, missile or weapon guidance, and the like, should have a training component added for exercising operators. The training algorithms including signal structure should be programmable by the operators.

- Instrumentation for force-on-force field engagements. (e.g., Mobile Sea Ranges, RED FLAG-type Ranges, etc.)

- Small/inexpensive devices for unit training in gunning and maintenance

2. Organizational Opportunities to Support/Improve Operational Training

- Focus on it
- Resource it with dollars, talented people, devices, aids and courseware

- Make it easy for innovation to take place quickly and be validated quickly

- Recognize schoolhouse support units and improve coordination and hand-off of training technology

- Improve training strategies and climate (reduce turbulence)

- Identify role of training contractors to take advantage of virtues and commercial strengths

- Establish "new initiatives" program for field commanders to start a solution of an immediate problem

- "Clean up" organizational responsibilities

- Make use of modern multi-use ranges and facilities

- Rely heavily on operator-defined training needs; place demonstration systems in the field for "realistic" evaluation and update in an evolutionary fashion

MANPOWER ACQUISITION AND SKILL TRAINING

SUBPANEL II

Co-Chairmen:	Dr. James W. Singleton
	Mr. Peter D. Weddle
Members:	Dr. Dexter Fletcher
	Dr. Susan R. Nevas
	Dr. Gerald F. Tape

INTRODUCTION

The manpower acquisition and skill training subpanel focused on the following:

- availability of manpower in the numbers and aptitudes required to sustain the active force;
- known and demonstrable technology applications to increase personnel learning rates, skill utilization, and proficiency;
- methods to closely couple defense weapon system design with available personnel skills;
- R&D opportunities to develop performance measures, to demonstrate promising applications of new technology, and to provide access to needed training data for future management decision making.

The following issues and recommendations represent the focal outcomes of the problem analysis.

ISSUE 1: Demographic projections and "technology creep" indicate future manpower problems of numbers and richness of mix.

The size of the country's primary recruiting pool is declining. The male population (18-24 years old) will decrease by 22 percent between 1980 and the mid-1990s; equally important, the latest census data reveal that the recovery from this situation will be much slower than originally expected.

There are also several disturbing trends in the quality or capability of this reduced pool. Estimates contained in the Department of Defense "Profile of American Youth" indicate that the median reading grade level of persons 18-23 years of age is now 9.6. Some minority groups are estimated to be two to three reading grade levels lower. The latter situation may, in part, be the product of an increase in the number of people who speak English as a second language. Minority representation in the manpower pool (18-24 year old) will grow from 20 to 30 percent by the year 2000; Hispanics will total 40 percent of that population. These are young Americans whose ability to perform and progress in society are limited more by cultural background than by their intrinsic capability.

This country has also experienced over 25 years of "significant declines" in the average scores in science and math on national tests such as the American College Test (ACT) and the Scholastic Aptitude Test (SAT). Equally disturbing, a lack of student interest in science was identified as a major problem by 50 percent of the teachers surveyed in a nationwide poll. Thus, as Dr. Joseph I. Lipson has noted, while the United States is one of the world's most advanced technological societies, it is "not providing the majority of our children with even the most rudimentary knowledge and skills necessary to contribute to, manage, and understand that society."*

The implications of that situation are particularly ominous for our Armed Forces. For example, inadequate scientific and

*Conference on Secondary Science and Math Education, University of Oklahoma, Norman, Oklahoma, May 7, 1982.

technical training is cited as the cause of a 90 percent failure rate in tests administered to 385 nuclear weapons maintenance specialists and a 98 percent failure rate for 371 tank turret and artillery repair personnel. Moreover, all of the military Services are increasing their reliance on technological sophistication in response to an external threat which is rapidly growing. As a result, the Air Force estimates that more than 65 percent of Air Force Specialty Codes will require a minimum aptitude index of 60 or above by the year 1990, up from less than 50 percent in 1960. Similarly, the Navy projects a 31 percent increase in its requirements for highly technical skills by 1986. The Army has labeled this situation "technological creep" and is itself forecasting a significant increase in required technical skills, having experienced a 92 percent increase in just two years, between 1980-1982. Despite laudable recent successes in meeting quantitative and qualitative recruiting goals, satisfying these future requirements will be problematic. Indeed, the Office of the Secretary of Defense is forecasting a ten percent decrease in the supply of quality accessions (male HSDGI-III) concurrent with an increase of 200,000 in military strength. Service projections do not differ significantly. The coincidence of such demographic projections and "technical creep" catalyzes severe military manpower problems both in number and richness of mix.

The following recommendations are made as initial steps to what ultimately must become a broad and vigorous effort to bring manpower capabilities and technology requirements into harmony.

Recommendations

1. **Use technology to reduce failure rates and simplify operator/ maintainer tasks.**

As noted in the Defense Science Board 1981 Summer Study Panel on Operational Readiness with High Performance Systems, "For systems of equivalent performance and cost, application of new technology actually increases reliability." Technological complexity also increases the unit cost of a maintenance action. Therefore, it is imperative that the frequency of such actions be decreased. The state-of-the-art is such that extremely long periods between unscheduled maintenance actions can now be achieved. For example, design requirements for the Navy's Submarine Advanced Combat System (SUBACS) specify a 60-day maintenance-free mission. Maintenance manpower requirements can, as a result, be decreased for systems properly designed with such technology.

Equally important, systems can and should be designed so as to simplify operator and maintenance tasks. For example, built-in test equipment (BITE), if properly implemented in high-performance systems, can facilitate repair by lesser skilled Service personnel. Built-in equipment performance measurement and training aids, including the technology of speech synthesis and/or voice recognition, can provide emergency instructions for equipment malfunction, equipment start-up and shut-down checklists, operations tutorials, recording of actions for feedback and analysis, and practice testing and drill in complex procedural sequencing tasks. Embedding such technology in the design of new systems, however, will be accomplished only if the requirement is meaningfully transmitted to industry and incentivized. An informal survey conducted by the Army's Soldier Support Center indicated that industry welcomed both the requirement and the information necessary to prosecute it.

Consequently, project offices should be required to <u>use technology to reduce failure rates and simplify operator/maintainer tasks</u>. The cost of doing so would probably not exceed two percent of each system's full scale engineering development cost.

2. Explore arcade-like devices to increase performance level of recruits.

From the explosive growth and profitability of electronic games in the civilian sector, it is clear that these devices are:

- highly motivating -- especially for the population of people the military must attract,
- relatively low cost -- the ratio of the costs of the games to what they simulate is small (when produced in quantity),
- relatively instructor free -- players learn to use the games with minimal instruction,
- relatively language-free -- lectures and text are not part of these activities,
- instructive -- people improve in their performance on the games,
- portable -- the devices are easy to install and use.

The appeal of these devices is attested to by the fact that receipts from the video game "Pac-Man" exceeded those of the movie "Raiders of the Lost Ark." Further, these devices can provide massive amounts of self-motivating practice in diverse and widely dispersed locations. Finally, these devices may be particularly appealing to people who have turned away from the traditional instructional modes of text and lecture.

However, the important question remains: can these devices promote military-relevant skills? More precisely, can the technology of electronic games be exploited to develop instructional devices that provide substantial transfer of expertise from electronic games to military job requirements? Can we successfully exploit these devices to increase recruit potential, to teach, and to improve military job performance? The evident promise of these devices demands a comprehensive exploration of their potential for school and unit training. For this reason, we recommend an immediate research and development program to determine if military training value can be extracted from these devices.

3. Require use of contemporary analytic methodology such as Navy HARDMAN, Army MIST, to match hardware to people.

To preserve the mission capability of new defense systems, these systems must be designed for the people who are likely to operate and maintain them. Matching hardware to people, however, requires special analytical tools. Studies have shown that 70-85 percent of a developing system's life-cycle cost decisions are made before that system enters full-scale engineering development. Hence, if human resource considerations (e.g., available skill levels and cost and time to train) are to cost-effectively influence an emerging system's design, they must do so early in its development cycle. Models and/or methodologies which (1) could operate with the quality and quantity of new system data available during this early period and (2) provide output products meaningful to both design engineers and training system developers have only recently evolved.

Over the past five years, the Navy has developed an integrated family of models and data bases designed specifically to assess the manpower, personnel, and training implications of a new system. This methodology, called HARDMAN for Military Manpower/Hardware Integration, has been successfully tested in all of the Navy's major warfare areas. Additionally, the Army has successfully tested a modified version of the HARDMAN methodology, and is currently developing a more automated and robust analytical capability in its Man Integrated Systems Technology (MIST). HARDMAN estimates of human resource requirements for a new system are derived by carefully controlled extrapolations from similar, deployed systems, taking into account differences in scenario and/or employment doctrine. In this approach, the range of unknown characteristics for an emerging system is minimized by comparing its component systems and subsystems to those with field experience. Hence, the requirements can be determined very early in system development and are supported with mature, historical data useful to engineers and behavioral scientists alike.

Analytical tools such as HARDMAN appear to offer Program Managers, Acquisition Authorities, and their staffs the necessary and important capability to estimate the human resource "demands" of a new system concept and to assess that demand in light of projected service supply. This information operates not as a constraint on system capability, but rather as a design specification to insure system effectiveness once fielded. Consequently, all new programs should be required to use a contemporary analytic methodology such as HARDMAN to match hardware to people. The cost per system would be approximately $3M per major system (from DSARC Milestone O-III) and less for smaller systems.

ISSUE 2: Educational deficits can result in serious underutilization of recruit talent.

The military services experienced their best year since 1974 in their recruiting record for 1981; all recruiting goals were met and were at the highest level of quality measured in proportion of high-school degree graduates (HSDG). The same or better experience is in prospect for 1982. Nonetheless, a strong case can be made for the proposition that we are late in preparing for the military manpower shortage almost certain to materialize in the 1985 time period and beyond.

Reasons for the expected shortage are to a large extent built into the population structure of the country: by 1985 the manpower pool of males in the recruiting age range 18-24 will drop 7 percent from the 1982 level continuing to a projected total decline of some 22 percent by 1996. The composition of the available pool indicates a continuing growth in the proportion of youth most likely to exhibit educational and language deficiencies creating a progressively larger problem of basic skills remediation. Further, we expect the economy to revive, bringing industry more aggressively back into the hiring market for talented youth. And finally, the skill requirements of the Services themselves will increase rather dramatically in response to the "technological creep" associated with force modernization. The Air Force, for example, expects the demand for skilled electronics technicians to increase by 33 percent in the next 15 years. The conjunction of these circumstances presents a first-order challenge to meet future manpower needs.

Recommendations

1. Develop technology to match instruction to ways recruits learn best.

The arrival of recruits with educational deficits draws attention to the principle that instruction should be delivered in the most efficient form possible. Basic to efficiency are two kinds of matching. First, the material to be taught needs to be matched with the media and format which conveys it best. Second, the mode of presentation needs to be matched to the learning skills and styles of the trainees. The first item is a content or subject matter match, the second is a people match.

For initial skill training of individuals with educational deficits, both considerations point to the same forms of instructional delivery. Service personnel must learn how to operate equipment and machinery or how to fix it. The content is not theory, intellectual abstractions, or data but procedures involving physical manipulation of objects and eye-hand coordination. Such things are best taught, not through print, but through pictures and demonstrations: visual images, live or recorded. Accompanying explanations can be communicated just as easily by the spoken as by the written word. Indeed, oral explanations leave the eyes free to focus on visual images.

The use of spoken words and pictures is not the only area where content and people considerations point in the same directions. Another is the use of active and interactive modes of learning as opposed to formats where the learner is primarily a passive recipient of information. The usual form of interaction is feedback, during or soon after performance, about what was done right or wrong. Young people whose experience in a frequently passive classroom role has been marked by failure are even more likely to prefer a contrast. Considering the characteristics of the new recruit population simply add weight to an already strong case.

These principles are worth implementing in instructional design by whatever means prove feasible. However, the panel wishes to point out the unique relevance of certain technologies for the purpose. Computer-aided instruction and computer-based simulations are highly interactive. With differing degrees of realism, they allow a person to run through an operation step by step and to get feedback on how he is doing. Meanwhile microprocessors coupled with videodisc players permit interactive systems to deliver instruction in the form of both film and still pictures accompanied by an audio track. Still another feature of interactive computeraided instruction matches another common learner need, particularly among trainees with learning difficulties. That is, it allows a person to repeat the lesson over and over. Experts on learning difficulties have emphasized that "overlearning" through multiple examples is key to retention. A related feature of disc-based systems is their ability to stop a picture to permit the student to study it, or to run a film sequence in slow motion which facilitates a closer look at a process.

What happens when instruction is harder than it needs to be because matching principles are ignored? Obviously training is likely to take longer and "take" less well. Costs attach to both outcomes. Poorly designed training also drives the personnel system into inefficiencies. When instruction for particular specialties demands skills (reading for example) at levels in excess of those required to do the actual jobs, the effect is to screen out people who could do those jobs. It also locks into the selection and classification system standards unrelated to job performance. Meanwhile, service people who do read well and could be "saved" for jobs which actually demand good reading are wasted on jobs below their capacity because less skilled people are barred from qualifying for them.

Controlling the level of learning skills demanded by training courses is not to be confused with diluting content. The issue here is delivery mechanisms and the proposition that they should not become hurdles in and of themselves. Control of learning skill demands is not to be confused with holding people back and keeping them "stupid." We are heartily in favor of equipping people to learn all they can as succeeding recommendations demonstrate. The plea here, rather, is to use people's learning skills economically. Don't call out the bulldozers when a trowel would do. By all means teach people to read better but don't ask them to read until it makes a difference: when the subject is best learned through reading.

2. Use innovative ways to teach necessary English language skills.

The proportion of the recruit manpower pool to whom English is not a first language is continuing to increase. The proportion to whom English language literacy deficits are a barrier to military success is already large. Together these conditions present a challenge to DoD to develop mechanisms to remediate language skills to achieve the highest utilization of recruit talents. Underclassification is the outcome to be avoided since this destines service personnel to learn and work below their ability levels throughout their career. Present language instruction provided in basic skills programs conducted by the services is typically too little and too late to influence the classification decision.

One possibility worth exploring is to offer language instruction during the Delayed Entry Program (DEP) during which time the recruit is nominally made a member of the Reserves.

The recruit is subject to call for specified duties which could include language training, and for which pay may or may not be required. Finally, most nearly in line with current practice, language training can be expanded as a prerequisite to attendance at technical schools in order to improve the recruits' opportunity to master the technical training material to be provided.

Technology should not be overlooked as the mechanism to make language training available in units on an off-duty basis. Conventional language training cassettes designed for military vocabulary can be prepared, and speech recognition devices can be made available to influence the adoption of easily understood accents. The latter become more important as the serviceman progresses in rank to the NCO leadership levels.

The existing service schools are the appropriate implementing agencies to sponsor these innovations recognizing the necessity to work both frontwards and backwards: backwards to the recruiting commands and frontwards to the force commands responsible for on-site unit training. Our estimate of cost to explore and develop the necessary language remediation programs is $5M per year across the services; implementation costs will be determined on the basis of programs recommended for adoption.

3. Use technology such as video (disc, tape) storage in the school and in the field to teach students about the equipment to which they are assigned.

One of a unit commander's first responsibilities is to make his people proficient and productive as quickly as possible. Military schools, however, can rarely prepare individuals for specific job assignments in specific units. Schools must necessarily focus on occupational specialties and leave job-specific training to units, which generally have unique mixes of missions, equipments, material, and personnel. For instance, a Navy electronics technician can be assigned to one of more than 500 commands and to a variety of equipment ranging in age from 30 years to one month. An Army wheeled-vehicle repairer can be assigned to a set of two to five wheeled vehicles out of a full set exceeding 50 at one or two of five echelons of maintenance. A school system that tried to prepare every trainee for every job assignment possible would be exorbitant in cost and inefficient in operation.

The inevitable and necessary result is that every individual who arrives in a new unit and a new job assignment requires additional individual skill training. This training is the responsibility of the unit commander. Generally, the unit commander has little time and less resources with which to answer this need for individual training. Nonetheless, the need to accomplish this training is great. If he fails, the proficiency of his unit will suffer, and the dollar cost of failure is very high.

One answer is to provide devices to units that are:

- portable and widely distributable
- useable for both training and job-performance aiding
- easily modified and updated
- relatively inexpensive (e.g., $500 per copy)
- relatively instructor free
- reliable
- standardized
- job relevant

Technology based on videodisc storage, hand-held computers, flat displays, etc., using the newer approaches to instructional software makes such devices practicable and available. These devices should be developed and evaluated for their ability to close the gap between what schools must teach and what the units require. We recommend a vigorous research and development effort to provide initial impetus in this area.

4. Use transportable devices in the field to broaden understanding for career growth and leadership.

Provision of adequate and integrated job performance aids and job-site training devices will go far to satisfy the unit commander's need to extract productive job performance from each individual under his command. However, the individual will not remain in his current job assignment forever. In addition to making an individual productive quickly, the unit commander also has an obligation to provide that individual with the basic skills and broader understanding that enables him to learn more quickly in his next assignment and to qualify for promotion and higher skill level certification. These basic skills include:

- functional literacy (e.g., reading, chart interpretation, and mathematics) in the occupation speciality
- rudimentary education in the background and academic theory underlying the occupation speciality
- learning strategies to obtain information from standard reference materials such as manuals, and to qualify for promotion

Low cost, stand-alone devices that do not further burden either a unit commander's time or budget should be quickly developed and evaluated for their ability to meet this need. Material presented on these devices should be graduated in difficulty and calibrated so that individuals can determine when they have reached identifiable milestones in progress toward skill advancement and promotion. We recommend a research and development program of $5M per year for each of five years to develop this capability.

ISSUE 3: Benefits of computer-based instruction and new technology for field refresher training are limited by slow introduction into the training base.

Conducting and managing training, whether in the unit or in the schoolhouse, is an arduous and complex task. Often that task is compounded by a shortage of personnel, equipment, and resources. Any attempts to introduce change into that environment, regardless of how beneficial that change ultimately may be, will create a degree of stress and turmoil for the recipients. Therefore, such change is often resisted. Further resistance arises from skepticism or simply from the belief that the "system" is working well enough already. Short-timers are reluctant to invest the energy required to learn and use new technology, since by the time they would become proficient with it they presumably would no longer need it. Also, the rapid growth of technology has given rise to the sardonic phrase "If it works, it must be out of date." The corollary is "If it's new, it's probably full of glitches." Hence, the attitude in the field is often less than enthusiastic about a new idea.

There are many reasons, therefore, why new technology is not embraced at face value by the intended users. Regardless of how shortsighted or irrational these reasons may seem to the proponents of innovation, they must be accepted as real obstacles to be dealt with systematically and convincingly.

The following steps are recommended to begin overcoming the basic resistance to change.

Recommendations

1. Innovate ways to make trainers accept technology changes such as CAI, and learn to use them.

   At least one study* has demonstrated that resistance to the use of new training technology comes more from trainers

*Jesse Orlansky and Joseph String, "Cost Effectiveness of Computer Based Instruction in Military Training," IDA Paper P-1375, April 1979.

than from students. While there are other factors which militate against successful introduction (e.g., constrained public school budgets and the cost and develpmental lead time of courseware), the Defense Department can take a major step forward on skill training by using innovative approaches to integrating new technology into training programs/systems.

There is potentially a wide range of strategies for overcoming trainer resistance. This DSB Panel could not possibly list them all or presume to identify a priority among them. Be that as it may, the panel believes that efforts in the following general areas would promote acceptance: (1) overcoming fear by training trainers in new teaching skills involving technology, (2) encouraging ownership by including trainers in the development of new courses with embedded technology, and (3) rewarding technology's use by advancing those who do. Trainers must be taught to recognize the potential of technology and its role in their efforts to educate service personnel.

2. Accelerate introduction of CAI into the "schoolhouse" to allow transportability of this training to the field and build CAI into training packages of all new operational systems.

CAI has demonstrated cost effectiveness for appropriate instructional applications throughout the military service school environment. Available data shows an average of over 30 percent reduction in student time to achieve the same learning level on the part of the student. Alternatively, and we endorse this strategy, a significant additional learning increment can be achieved within the same time, producing reinforcement of critical learning, enriched learning for increased effectiveness, and extended learning for more rapid career advancement.

Additionally, use of greatly expanded CAI in service schools makes practical the achievement of one of the most important advantages of the technology: use of CAI in on-site unit training for refresher and other training in the field.

Familiarity with and effective employment of this teaching technology depends on its introduction to the soldier, sailor, and airman in the institutional school setting. Expecting the serviceman to adopt it "cold" in the field setting is not realistic.

We estimate that service schools will be able to devote an aggregate of $40M additional per year for five years to accomplish the arduous job of authoring existing courses for CAI delivery and of authoring new courses in this delivery mode. An additional $6M per year for five years is estimated for the acquisition of CAI hardware. Thereafter, course modification and new course introduction should be capable of CAI formatting within normal budgetary allowances for curriculum development.

Future systems can effectively and efficiently be prepared for CAI instruction without conversion cost by building in this curriculum delivery method as a part of the New Equipment Training Package (NETP) developed by the system contractor(s). It is the sub-panel's belief that the portion of such NET packages susceptible to CAI instructional delivery will normally range from 20 to 60 percent or higher and should be maximized at this strategic window of opportunity. A fixed numerical proportion has not been established, simply because of the range of idiosyncracies which may be encountered in operational systems.

NET Packages have been singled out because they are typically taught by the contractor to service school instructors designated as classroom teachers for students -- training the trainers, so to speak. We believe introduction to the CAI delivery mode by the service instructors will be effective in overcoming or preventing personal resistance to the new technology, which often arises when an instructor must retrofit a course to a different and unfamiliar instructional delivery method.

To implement the contractor's NETP preparation in the greatest practicable CAI format, we estimate the cost to be one-half percent to ten percent of system cost.

3. Build CAI into training packages of all new operational systems

Without violating the principles of sound instructional systems development (wherein media selection derives from the behavioral training objectives) there is the need for serious evaluation of CAI early in the weapon systems development cycle. Enough is known generically about the operating and maintenance skills required of weapon systems and the increasing shortage of skilled instructors to decide early on whether CAI is a strong candidate for a given weapon. If the answer to the evaluation is "yes", then a training system development plan should be developed immediately and followed through. In essence, CAI should be given the option of first refusal.

ISSUE 4: Adequate data are not yet assembled to determine cost-effectiveness of training methods and devices.

For any weapon system and any set of training objectives, there are numerous training strategies and media. The magnitude of the training challenge and the complexity of both the weapons systems and the associated training technology requires a sufficiently comprehensive and powerful decision data base in choosing the best alternatives. That data base is not available at present, and the traditional system-by-system, piece-by-piece approach is becoming increasingly inadequate. The basic solution entails at least four major steps as reflected in the recommendations offered below. In brief, a broad and systematic effort is required in training technology and procurement that will tell us what aspects of learning/performance should be measured and how to measure them, how best to use embedded instruction to unburden the human instructor base, and how to weigh the cost-effectiveness variables in arriving at a prudent selection. We need to get better data, have a place to keep them and a way to use them.

Recommendations

1. Undertake demonstration projects for training and performance measurement.

The Services have been performing research and development on CAI/CMI for more than 15 years. It is time to implement this promising technology in a wide range of military organizations and commands. The opportunity made available by this technology centers on two characteristics: (1) it is relatively inexpensive, and (2) it is highly motivating to students.

The requirement for this technology hinges on the observation that expertise requires an amount of experience and practice that is unavailable at job sites and is impracticable in residential training. CAI/CMI with related technologies based on videodisc, speech input, speech output, and computer generated imagery, appears to offer the only serious promise for providing integrated schoolhouse and job-site (or unit) training in which practice of sufficient quantity and quality to develop and sustain the proficiency needed for personnel readiness can be supplied. That is to say CAI/CMI can provide training that is:

* integrated across schools and job sites
* physically accessible
* relatively inexpensive
* self motivating
* relatively instructor free
* easily updated
* safe, i.e., provides instruction in dangerous but necessary skills.

We recommend that at least one "tail to tooth" demonstration project per Service be undertaken. The projects should have the following attributes:

- They should be system level. This is to say that the full range of training from initial skill acquisition in institutional settings to job-site training in units should be included and integrated in each of these projects. A project that focuses only on training in the schoolhouse or on training in the unit would be unsatisfactory. Further, the aim should be to improve performance and productivity in a system area such as satellite communications, sonar operation, or F-14 avionics.

- They should emphasize state-of-the-art hardware, software, and courseware. It is not intended that these projects undertake major innovations in the area of CAI/CMI. However, the projects should take full advantage of the state-of-the-art in CAI/CMI and they should be sufficiently flexible to advance in their approaches as the state-of-the-art does.

- They should collect accurate, credible, and easily coordinated cost data. There should be very little compromise on this issue. Data on course preparation, software, and hardware costs are far too scarce and incomplete given the importance of these issues and the time spent in research and development on CAI/CMI. These projects represent a major opportunity to collect data of this sort, and the opportunity should not be lost.

- Measures of success should focus on individual skill proficiency in units. End-of-course performance data by themselves will not suffice for these projects. On-the-job supervisor ratings will also not suffice. Individual skill and performance in the unit -- especially as they relate to unit effectiveness -- must be the principal measure of merit for these projects. In many cases it will be necessary to develop appropriate measurement instruments.

- They should be well funded. These projects should have sufficient funds to buy a reasonable number of devices that appear to have potential and to make them available to people in schools and units so that meaningful tests of their potential can be accomplished.

- They should begin soon. The simple and most fundamental issue behind this recommendation is to find out as quickly as possible the extent to which DoD training can take advantage of CAI/CMI technology.

A second aspect of this recommendation concerns the establishment of training technology testbeds. At least one testbed should be established per service. At least one of these testbeds should be established in a military residential school, and at least one should be established in an operational unit. The testbeds differ from the demonstration projects in that:

- they represent a half-way point between laboratory studies and full demonstration projects

- they are smaller in scope than the system-level orientation of the demonstration projects

- they are more experimental in nature and are expected to support efforts to push the state-of-the-art

- they should be more amenable to the control of presentation and collection of detailed effectiveness data needed to determine treatment/outcome relationships

The service research and development communities have long been hampered in their attempts to field promising new approaches and technologies because of a "catch-22" relationship with operators: the operators will not implement training innovations until researchers prove their utility, and the researchers cannot prove utility until operators accept the innovations and try them out. It is time to cut through this problem. There are few, if any, incentives for a commander to take on a research and development task. With the testbeds we will institutionalize a few organizations and experimental schools and units that will have as part of their mission the requirement to participate in research and development efforts to field promising new technologies.

We estimate the cost of carrying out this recommendation to be $16M per year for each of five years.

2. Embedded Training -- Development and Use

Embedded training and performance measurement signifies the incorporation of capability in (typically, but not exclusively) a computer-based system for generating target or threat data to be fed into and through the operational equipments, permitting operations personnel to take normal actions to counter that threat as they would be required to do in real life; the threat, the operator actions taken, and the results are recorded for analysis and feedback. Most sensor systems, weapons systems, and command-control systems in current use and in development incorporate computers as an integral feature of their design. These form the medium for incorporation of the embedded training and performance measurement capabilities.

Advantages of embedded training and performance measurement are many and obvious: ease of scheduling and administration; low cost to use; availability at sea or on remote duty stations; and, most important, the reinforcement of operators' real behaviors on their operational equipment to maximize transfer of training. Even the cost of development is modest if the design requirement is established at the outset and hardware features are explicitly engineered for the purpose, e.g., computer software capacity for generating and handling simulated data. Built in performance measurement and training aids, including the technologies of speech synthesis and/or voice recognition also show great promise for speeding on-the-job learning and enhancing individual and systems performance by reducing operator and maintainer errors. Some examples of the possibilities are:

- Automated visual and/or audible instructions for handling equipment malfunctions.

- Automated interactive visual and/or audible equipment start-up, shut down, and check-out and troubleshooting procedures checklists.

- Automated recording and analysis of actions, sequences, intervals, directions, etc., for performance assessment and feedback.

- Automated interactive practice testing and drill in complex operator and maintainer tasks.

To capitalize on techniques and technologies available in this area, the following actions are recommended:

- Require each Service to assess the potential of embedded training and performance measurement in major materiel development projects; the results of such assessment are to be reported for review.

- Require each service to continually assess the potential of embedded training and performance measure in all future major materiel development and to report the results of these assessments at appropriate program review milestones.

3. Develop and Adopt Measures of Individual Performance

The Army is embarked on a major R&D program to develop and validate new and improved training and job performance measures. This program will focus on the application of advanced technology, especially electronic technology, to enhance the validity and reliability of these measures and to reduce the cost of their collection and analysis. Given the critical importance of accurate individual performance data for training assessment, it is recommended that each of the services be directed to initiate R&D programs equivalent in purpose and scope to the current Army program which is under the sponsorship of the Army Research Institute.

It is estimated that the five-year cost of such program would be $15M per Service. The OSD action agent for appropriate tasking to the Air Force, Navy, and Marine Corps is the OASD (MRA&L).

ISSUE 5: Establish a repository (center) for all training data.

<u>Recommendation</u>

It is now difficult to collect basic information needed to determine the effectiveness of military training, such as the relation between student achievement at school and performance on the job, the relation between individual skill training at schools and the performance of crews and units in operational commands; the relative retention of skills by students when either conventional classroom or computerbased instruction is used for the same courses at school, and whether different methods of instruction (e.g., conventional or computer-based) should be used for fast and slow learners. A major reason for this difficulty is that training is significantly influenced by actions taken in different types of commands (e.g., recruiting, training, and operational) and that the data needed to assess the effectiveness of training are not now available in any one place. The types of information needed to evaluate the relevance and effectiveness of training for different types of military jobs include education, job history, and test scores at time of initial entry to military service (from the recruiting records), courses taken and test scores (from the training commands), and on-the-job training and performance data (from the operational commands). Some, but not all, of this information may be found in personnel records of the services and the Defense Manpower Data Center; it has not yet been applied to studies of training.

Other types of training-related data have not been collected in any place. These would include the methods of instruction, types of media, and types of simulators used in various courses; it is particularly important to associate this general type of information with the training of individual students in order to assess the relative effectiveness of different methods (or courses) of instruction. It is necessary to be able to associate scores during individual training at schools with unit training scores in operational units. It is necessary to be able to associate unit training scores with performance of those units in field exercises, both in operational units. It should be possible to compare individual and unit training data with critical performance data now becoming available from such sources as the National Training Center, air and sea combat maneuvering ranges, and various joint and combined exercises.

It is obvious that the effectiveness of training depends strongly on the amount of resources allocated both to research on training and to various types of actual training in such terms as, e.g., amount of student time, number of instructors, quality of equipment provided for training, number and fidelity of simulators, and amount of flight time and ammunition provided for training. Therefore, a Defense Training Data Center should also collect data on costs associated with various type of training, RDTE, acquisition and support of simulators, training devices, courses, and facilities.

It is recommended that an OSD field agency be designated to implement a Defense Training Data Center. Cost is estimated at $1M per year for five years.

ISSUE 6: Field-based aids -- Technical manuals, orders, and job performance aids (JPAs) continue to be produced in forms that defy easy use and fail to connect with school instruction. In addition, there is no reliable system for insuring that manuals, orders, and JPAs are rapidly adjusted to reflect engineering changes.

No matter how effective skill training courses are, Service personnel need a useful performance aid to help them remember what they have forgotten and to help them handle new situations. The system continues to produce technical manuals, orders, and JPAs which, for a variety of reasons, are less useful than they might be. First, aids are often hard to use. Second, initial skills training and field-based aids have not been integrated into an overall system with a comprehensive strategy. Most notably absent is a strategy for promoting retention. Third, there is as yet no reliable system for insuring that changes are promptly and uniformly reflected in aids of all kinds.

The first problem has been recognized and addressed in part, but, so far, not as effectively as it needs to be. The second and third problems have scarcely been touched. All bear some elaboration.

Barriers to Easy Use

Despite some progress on the subject, too many aids are still hard to use. Frequently, finding the right piece of information for the task at hand is a formidable undertaking. At the same time, there is often too much information, written and presented in ways that are hard to grasp and disconnected from the way the school teaches the same subject.

The situation is costly in several ways. Part of the price is indirect. When the reading level of manuals and aids is unnecessarily high, qualifications unrelated to job performance are locked into the selection and classification system. The effect is similar to that of overemphasizing literacy in school training courses.

The direct costs are more obvious. When performance aids differ from school courses, school learning erodes more rapidly. Errors increase, and problems are fixed more slowly.

Programs like the Army Skill Performance Aid (SPA) system exist to correct the problem. However, key provisions can be and often are waived. The requirement, for example, to test a new aid on a target group of typical users is often skipped because it is costly and time-consuming. Enforcement of such provisions would go a long way toward fixing the situation.

School/Field Disconnects and the Retention Problem

Failure to exploit connections between field aids and school training creates costly and troublesome disconnects. It also misses an opportunity to reinforce initial instruction and so sustain its efficiency. Initial skills training and field aids ought to be viewed as a total system, designed so that the parts are fully complementary. It is important to insure that information and concepts match. A more difficult job, but one which promises substantial payoff, is to tie school instruction and field aids into an overall strategy.

Field aids exist primarily to make up for the shortcomings of the human memory. Their main purpose is either to remind the Service person of forgotten training material or to provide information left out of training, often on the theory that inclusion would overtax the trainee's memory.

Memory lapse is a problem for everyone, not just for the lower ability end of the recruit spectrum. When a field aid aims at reminding Service personnel of what they once learned, the salient issue ought to be: what is the most efficient (meaning partly, the quickest) way to restore memory? Obviously, the greatest efficiency is achieved if a person remembers perfectly and needs to spend no time refreshing recall. The least efficient, most time-consuming process is to review the initial instruction in its entirety (or perhaps, as some orders provide, in even greater detail than the original).

A memory aid worthy of the term ought to fall between the two extremes, preferably at the more economical end of the range. Perhaps there should even be several levels of recall aids available via rapid electronic access, so that a trainee who needs only a hint is not provided a treatise. Such a system would also enable a person to start with the most abbreviated prompt and escalate as needed.

Whatever the outlines of an efficient system may be, certainly there is wisdom in exploring the state-of-the-art regarding ways to evoke recall. Existing field aids reveal few traces of such an effort.

A complementary issue in the recall area is the design of initial instruction, whether delivered in the schoolhouse or transferred to the field for delivery via embedded trainers or other devices. Unless the issue is addressed, too much of the retention burden will fall on aids. Aids are merely stopgaps for memory failure. They do nothing to insure retention in the first place. An effective system for producing retention, in fact, is one which minimizes the need for aids.

Failure to Reflect Hardware Changes

When hardware is first purchased, the accompanying field aids are normally in sync with its features. Once engineering adjustments are made, however, the match may deteriorate. Changes are not always fed into manuals, orders, and JPAs. Adjustments which are recorded are not always recorded uniformly; some field aids may be updated and others left as they were. To put it differently, what engineers call configuration control is missing or spotty.

As a result, some or all aids for a given piece of equipment sometimes diverge from the way the hardware really works. They are misleading rather than helpful in ways which are not even flagged. A corrective system is badly needed.

TRAINING TECHNOLOGY

SUBPANEL III

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TRAINING TECHNOLOGY

A. Introduction

This subpanel evaluated a variety of opportunities for enhancing the acquisition, management, and presentation of military training. It concluded that much of the difficulty faced in training today and in the future stems from two important trends -- a shortage of high quality personnel (students and instructors) and a continuing increase in the sophistication and complexity of military weapon and support systems. These trends have given rise to several important needs:

- unburden (but do not replace) instructors
- unburden students (through more efficient and adaptive training)
- increase training efficiency by using available new technology (stand-alone computer-assisted instruction, videodiscs, maintenance simulators)
- increase training efficiency by redistributing it (schoolhouse, on-the-job, etc.)
- keep training current with their weapon/support systems (instructional information for students, operators, maintainers)
- accelerate training at school, increase retention of knowledge and skills on the job
- increase scale and realism of training to match operational performance objectives
- reduce cost of training
- increase the effectiveness of training

The subpanel examined available and emerging technology as a means of meeting these representative needs. This task included an examination of the manner and extent to which the Services are using and are planning to use new training technology. In brief, this subpanel found that new and currently available technology can provide extensive assistance to the military training community, in each of the areas listed above. Key forms of technology to be considered are:

- high speed, high volume, random access information systems

- intelligent systems (in the schoolhouse, as stand-alone items in the field, or embedded in the operational system) for interactive, adaptive, realistic training

- advanced telecommunications (via satellite networks) for high speed distribution and updating of training for remote or dispersed locations

- arcade game technology to enhance instructional interaction, reduce reliance on reading in teaching non-verbal skills, and increase learner motivation.

The foregoing examples of technology applications are not offered as a panacea. While the physical technology (hardware) itself has immense potential, the time and money needed to develop and to update software and courseware are substantial. These latter costs may and often do run as high as ten times those of the hardware. Notwithstanding this obstacle, vigorous pursuit of advanced technology for training is seen by this panel to be necessary and at the same time to offer the greatest payoff both in military training effectiveness and in cost reduction.

The following section discusses some of the needs, opportunities and possible solutions inherent in present and future training technology. The discussion is followed by several specific recommendations intended to provide initial direction and impetus to taking maximum advantage of technology for training.

B. Discussion

The training needs of the Services and the technologies that may be brought to bear on those needs are too extensive and complex to be addressed in any detail here. Therefore, the object is to highlight areas that appear to hold the most promise. Unlike the development of weapon systems much of the technology useful for military training has been and continues to be developed by and for the private sector. In addition, present and emerging technology in visual and audio/speech systems, and global communications systems now offer capabilities and options that were not posible even a few short years ago.

1. Drawing on Private Sector Technology

Led by the rapid development of the microprocessor, the private sector is creating both a new information industry that combines microprocessors, communications interfaces, large mass storage devices and an educational delivery industry that combines the microprocessor, video disc, and touch-sensitive video displays. DoD has instituted several studies using intelligent interactive delivery systems that range from tank maintenance to shipboard electronics maintenance. The military should "piggy-back" on this technological revolution, finding its own special applications and creating only the software and courseware peculiar to its needs.

Technologies that improve weapon system performance also offer major opportunities to improve the ability of the Services to operate and maintain those systems through more effective training. Technology advances in civilian educational delivery systems, personal computing and information systems (based on the microprocessor, high speed memories, random access mass storage devices and communication) offer the opportunity for the Services to employ more cost-effective training technology.

2. Very High Speed Integrated Circuit (VHSIC)

A promising new technology is the Very High-Speed Integrated Circuit (VHSIC). The world of computational plenty is approaching, fueled by this next generation of microprocessor and memory development. Fiber optic local communications networks and new modem capability are also rapidly developing. The most promising future developments occur in the area of machine intelligence (also called artificial intelligence). These techniques, based on symbolic processing, will increase the efficiency with which courseware is prepared and delivered. It was felt by the committee that general evolutionary development of video display technology would allow much greater realism in future visual simulator systems. DoD must be ready to incorporate rapidly into its education and training systems those developments in the civilian sector.

3. Embedded Training

Advanced digital techniques allow much more flexibility in weapon systems than ever before. This trend will accelerate as VHSIC is inserted. Weapon systems already have used built-in test and built-in fault isolation with considerable success. This capability was possible only after digital technology was applied to weapon systems.

When space and safety considerations permit, simulations for training can be embedded in real weapons systems. Basically, they provide realistic target scenarios and performance measurement capabilities for use when the operational situation permits it. Judicious use of stand-alone devices can complement embedded systems. Stimulation packages can be electronically located as close as possible to the front end of weapons systems and can be programmed to carry out required scenarios as desired.

It appears that embedding a training capability in the system will allow non-destructive training in how to handle malfunctions in the field. It could be possible to program faults and changing environmental conditions (e.g., electronic warfare). This would allow quick refresher training in the field for operations and maintenance. The subpanel, however, saw no ongoing effort to investigate this possibility.

The value of the recommended technological approaches would depend in part on performance measurement. Trainees should have some indication of their performance. It appears that DoD has not considered objective performance measurement, as noted previously.

4. Fidelity of Simulation

No less than half of DoD expenditures for the development and acquisition of training equipment is spent on sophisticated simulators of aircraft, tanks, and ships. Much of that cost is devoted to attaining realism, particularly in visual imagery. This pursuit of realism through technological means occurs with little information about the degree of fidelity required to achieve optimal training benefits from such simulators. There is an urgent need to know more about how much fidelity is needed.

Because simulators cannot substitute for training in the real environment, but can only prepare the trainee to profit from actual flying and shooting weapons, the fidelity threshhold (and cost) required in simulators will largely determine the cost effectiveness of simulation equipment. A key to determination of fidelity thresholds will be the development of objective performance measures for simulations. In the absence of such measures, no firm basis exists in judging the degree of realism required to achieve a training objective. The subpanel feels strongly that existing data should be examined with such measures in mind. If data being acquired are inadequate, then necessary additional data should be collected. Subjective indicators such as trainee "satisfaction" with simulation cannot substitute for objective measures in assessing fidelity thresholds for sophisticated systems. The notion that user acceptance requires high fidelity, whether or not it contributes to effective training, is an unnecessary slur on the intelligence of users who are also taxpayers.

Our recommendations are aimed primarily at existing sophisticated simulators and those under development using current technologies. The advent of newer technologies (e.g., VHSIC) which allow expanded capabilities in fidelity demand more urgency on this matter. The objective in training is not to achieve maximum fidelity but to achieve that amount of fidelity needed to optimize the training effectiveness of simulators.

5. Transportable Software and Modular Courseware

Until lately, the decision to improve the hardware of computer-based instructional systems involved a further large investment in new software compatible with the new machine. Methodologies now make it possible to develop an initial software package that can be sufficiently transportable and flexible to accommodate changes in the hardware. An example of such a hardware transportable operating system is the University of California, San Diego, PASCAL P-systems, the third most prevalent microprocessor operating system behind CP/M and MS-DOS. Transportable software allows DoD to take advantage of the accelerating gains in computational hardware while encouraging competition among hardware vendors.

We view courseware as a special application of the generic term "software." It must be emphasized, however, that there are some technical and organizational problems remaining before existing systems permit rapid and cost-effective field modification of computer-based courseware. The use of common courseware modules with emphasis on "user friendly" software interfaces can yield immediate gains in efficiency and user acceptance of computer-based instructional systems. The present discussion has been concerned only with the technological feasibility and advantages of transportable software and modular courseware. Assuming that these improvements come into being, it will be advantageous to have a defense data center where these resources can be provided to all concerned with military training.

6. Use of Satellites in Presenting and Updating Training

The present system of communication regarding training of operators and maintainers in the field is based largely on paper. Compression techniques, beyond microfiche, have not been tapped by DoD. There is a gap in keeping technicians in the field up to date, and in adapting necessary training to the changes being made on weapon systems in the field due to technology or tactical requirements. Missing is the vital communications link through which that information must travel. Equipment modifications impact the readiness of the forces that depend on such equipment. In essence, then, timely and effective training and communications are congruent. A trained person will be able to perform effectively only if he is kept current.

Satellite communications exist in the commercial marketplace. It appears that those techniques can be applied in remote training, maintenance, technical manuals, or order updating. It is even possible to use satellite communications for teleconferring about maintenance. The panel's recommendations address the areas of research that can be applied to the special needs of DoD. Future interconnection with satellite and cellular communications networks will create distributed computer information systems, the global equivalent of today's local area networks. The capability to instantly disseminate information to widely dispersed locations will enhance the readiness levels of combat forces and their ability to maintain an increasingly complex mix of weapons systems that are continually being modified.

7. Voice/Speech Technology

In addition to microprocessors and associated memory devices, synthetic speech and speech recognition offer some powerful training applications. Pattern recognition algorithms for speech synthesis and speech recognition are well known. The communication industry (particularly telephone) has sought ways to synthesize speech from the limited bandwidth of available audio energy without losing intelligence. This is now possible with acoustic energy primarily in the .1-4KH band. The result is the ability to transmit significantly greater numbers of voice signals over a high-frequency communication path.

This technology also can store a large amount of audio (or voice) data because one can represent a complex signal by a low number of digital coefficients. Technologists in the training field have capitalized on this by storing on a single memory chip a long lecture (i,e., large numbers of spoken words can actually be placed into a helmet/headgear worn by a person perhaps changing a printed circuit board, or troubleshooting an electronic system.) In short, voice synthesis transcends by far even the most miniature of audio tape players. Automated voice recognition can be used, for example, in interactive computer-aided training. A student can ask questions of the computer or give answers as if the computer were a live person.

Voice response systems, using synthetic speech and a phone tone decoder, enable one to create instant response systems for educational course registration, test taking, and general real-time data retrieval. Voice recognition technology, just entering its second decade, will enable students to interact with training devices while their hands and feet are occupied.

Voice mail, with store and forwarding applications, is creating new industries in the civilian sectors. This will permit an instructor to leave voice annotations along with test results of students.

8. Advanced Displays

Advanced displays (thin-film; electroluminescent) will allow reductions in display size, as well as allow the screens to retain certain signals for a period of time, as in radar. Applications might include placing the visual read out (e.g., as seen by a current television viewer) on a 6 x 6 inch screen that may be carried in a briefcase. These displays also will enable more personal and portable devices to be used throughout the career of military personnel, following them from the schoolhouse to the flight line. Satellite communications promise the ability to link widely dispersed students and/or maintenance people in global networks. Such communication technology also permits the rapid dissemination of technical manual updates given the development of cost-effective, hard copy capable, earth stations.

C. Findings and Recommendations

1. Findings

- There are technologies, some quite advanced (in weapon systems, home computers, electronic games), that can be used to improve military training at all levels.

- Software is the dominant cost of computer-based instructional systems.

- Current courseware is exceedingly costly, accounting for some 90 percent of the cost of developing CAI systems and, once developed, is inflexible and difficult to change.

- There is great potential for improved training and performance measurement in weapon systems by use of stand-alone and embedded (organic) stimulation and simulation.

- Present high-fidelity real-time visual simulation systems are very expensive, and the thresholds needed for effective training are not established.

- VHSIC will improve the cost-effectiveness of simulation systems.

2. Recommendations

- USDRE should assign responsibility and allocate resources to assure full advantage is taken of these technologies in the design of new training devices. Two million dollars per year over a three-year period should be fruitful.

- USDRE and the training commands encourage the use of common courseware modules and "user friendly" software interfaces.

- USDRE should direct R&D efforts in machine intelligence emphasizing automatic programming, information extractions, expert-type systems and development of "good teacher" models. At a cost of $12 million per year for five years, this effort should result in significant cost reductions of courseware production and delivery.

- USDRE through DSARC should encourage embedded training in weapons systems where applicable. Based on the average cost of built-in test and fault-isolation, this effort would cost about 7-10 percent of the weapon system development cost but reduce overall life-cycle costs.

  A further recommendation is for the development and incorporation of performance measurement capabilities in new weapon systems. Performance measurement can provide fast information on personnel and equipment performance levels. The Materiel Development Agencies in conjunction with the R&D laboratories can implement this recommendation to develop the required methodology over a three-year period at $5 million per year. The cost of fielding this effort operationally is considered negligible.

- USDRE should increase research on the relation between the degree of fidelity and the effectiveness of equipment used for training individuals and units. This cost is estimated at $10 million per year over a five-year period. Also: USDRE urge cost-effectivenes evaluations of alternate solutions. These evaluations must be based on training effectiveness provided by realism. It is estimated that $1 million per year for five years could provide the answers.

- The Services should develop cost-effective ground stations with hardcopy reproduction and video recording capability at about $10 million. This must be a continuing effort until the field training is satisfied. Moreover, longer-term effort should be made to pursue technologies related to data compression. Finally, to hasten the exploitation of satellite communications capabilities, the panel urges USDRE to establish a study group from the training commands.

ORGANIZATION AND ACQUISITION

SUBPANEL IV

Co-Chairmen: Rear Admiral Rowland G. Freeman, III,

USN (Ret)

Dr. James F. Harvey

Members:

Brig. General William B. Burdeshaw, USA (Ret)

Mr. Robert P. Dirmeyer

Mr. Roger H. Mathews

ORGANIZATION AND ACQUISITION

A. Introduction

> "If training seems expensive, consider the price of ignorance."

Combat readiness is derived from adequate numbers of properly trained personnel manning the "tools" of combat operations. The focused application of training resources, management and research is essential to attaining a responsive and supportive DoD-wide training architecture. It is the purpose of the subpanel on Training Organization and Acquisition to assist the DoD in exploiting the full potential of training technology. An examination of the available data, testimony by senior DoD and industry representatives, and discussions among DSB members leads the panel to conclude that **a disparity exists between the perceived contributions to readiness that training technology can make and the attention given it at the budget table.** As an example, the data of Table 1 indicate that not only are the training R&D budgets miniscule, but the budget category title itself ("Training, medical, and other") says much of the relative unimportance of training technology in the R&D community.

It was the unanimous view of the DSB that training, a vital component of readiness, is given insufficient emphasis in the weapon acquisition effort. A rebalancing of priorities is essential.

The panel believes there are two aspects to the problem. First is the application of technology to the problem of individual and collective training. The 1976 DSB "Report of the Task Force on Training Technology" provides justification for the OSD and the military departments to expend resources on training technology R&D to support initial entry training. This panel finds the 1976 recommendations equally applicable today. Unfortunately little real activity has occurred in implementing the 1976 recommendations. The inactivity stems from several causes:

1. The OSD never fully embraced the notion that R&D could assist initial entry training techniques.

2. Real reductions in Program-8 funding. These reductions (Figure 1) provided a sterile climate for military department support of increased R&D on training problems.

3. Military departments were not organized to:

   - define and correlate training R&D requirements
   - program training R&D requirements in POM
   - designate R&D projects for specific Service laboratory support.

In effect the Services had not the means, the structure, or the focus to implement the 1976 Task Force recommendations. It must be said, however, that each Service has subsequently taken steps to improve their training R&D activities.

The second aspect of the problem is in the management and application of 6.1 - 6.4 funding for the acquisition of system and non-system training devices and simulators. Several areas are worth comment:

- The dollar threshold of POM interest in USDRE is insensitive to most training-related R&D activities.

After '76 Report (DSB) climate for increased monies and emphasis on training technology R&D was poor. FY 72-82 (see chart) essentially flat. Institutional Training Program 8T actually decline (see chart).

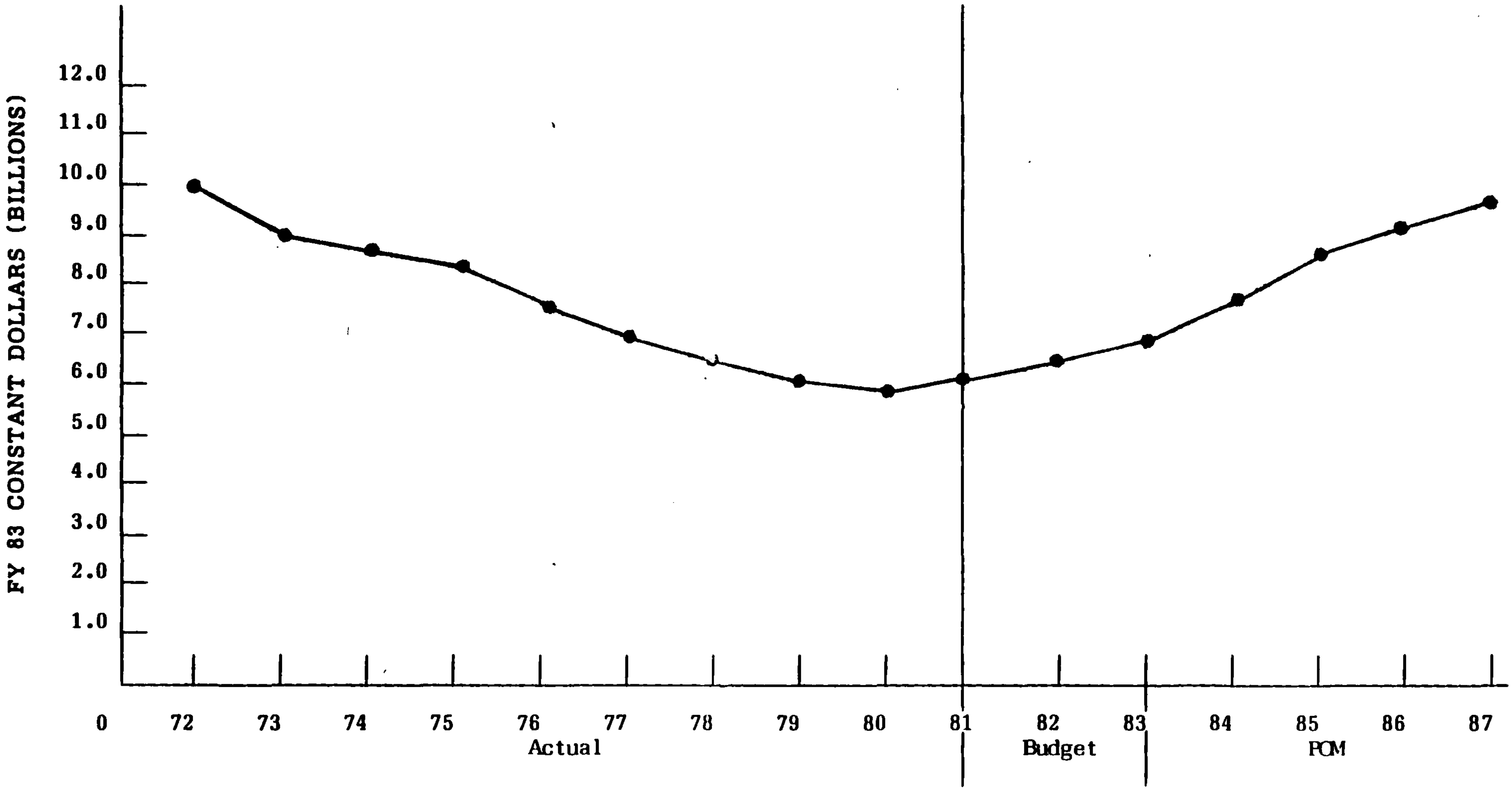

Figure 1: PROGRAM 8T - INSTITUTIONAL INDIVIDUAL TRAINING

- DARPA views near- to mid-range development activities as the responsibility of each Service. As a result an insignificant proportion of the DARPA budget is focused on training tasks.

- Service approach is generally fragmented in:

  - Ensuring the POM contains training R&D issues, programs, and/or planning

  - Providing the OSD a focal point for training R&D requirements, funding

  - Controlling laboratory 6.1 - 6.4 programs to develop a fertile environment for future training requirements (system and non-system).

B. <u>The Audit Trail of 1976 DSB Task Force on Training Recommendations Shows</u>:

<u>Army</u>

1. Army has created a Training Directorate in the ODCSOPS to:

   - Act as DA training proponent
   - Set Army training policy
   - Manage selected training issues

   (Training Directorate, however, does not have control over 6.1 - 6.4 funds)

2. Army has established in TRADOC

   - The Army Training Support Center at Fort Eustis, which includes:

     - Army Training Board
     - Directorate for Army ammunition, ranges and targets

- Army Communication Technology Office
- Directorate for systems, and non-systems, devices
- SOT Management Directorate
- Tactical Engagement Simulation Directorate

3. Reinforced PM TRADE's (Orlando, Florida) charter and increased funding support of those activities (X fold) 1976-1981.

Navy

1. Training sponsors established (SALZER Report, Nov. 1978):

   - Established the DCNO for Manpower, Personnel and Training (OP-01)
   - Requirement/Warfare Sponsor (OP-01/02/03/04/05/094/095/009)
   - Deleted OP-099 (DNET)
   - Established CNET as a major claimant/echelon 2 command
   - Directed Warfare/Requirement sponsors to fund/support both ongoing/new training initiatives within their respective TOAs.

2. HARDMAN program implemented 1978

   - Provides a standard methodology for manpower/training/life cycle cost development. Provides an information system which will support/document MPT requirements for all new acquisitions. Will improve MPT planning and trade-off analysis.
   - A 7-year program
   - Implementation for all new acquisition programs to be completed in 1984

3. A detailed, computer-based resource tracking/management system for all on-going training was developed.

- Provides for each requirement/warfare sponsor by individual/ group the course, instructor and student billets programmed, the support costs, the training devices used, the total student input for the execution/budget years and all FYDP years (i.e., it provides a base to start from).

- Documents new course requirements for each requirement/ warfare sponsor and documents the total resources required to implement the training.

- Places the requirement to support and fund on-going/new training initiatives on the requirement/warfare sponsor, not on OP-01/ CNET.

- Provides the means where OP-01, as the Training Mission Sponsor, can assess/evaluate training support during the Navy POM process.

4. OP-01 MPT inputs to the CNO Executive Board (CEB) concerning new weapon system acquisitions have been improved.

   - Improvements implemented in 1981.

   - Single point of contact within OP-01 now charged to review/ comment on all acquisition programs during the CEB review.

   - OP-01 flag officer participation now directed for all CEBs.

   - MPT issues/status now routinely reviewed and discussed during CEB review.

   - OP-01/CNET now represented on the CHNAVMAT Logistic Review Group (LRG).

   - Adequate Logistic Support and MPT support required prior to proceeding to each step in the WSAP process.

C. Army Training Systems

With the establishment of TRADOC in 1973, the Army provided command focus to training management through a single command element responsible for initial entry training, the Army schools system, and Army training technology requirements. From 1973 to present, the TRADOC system has matured to a functional element of the Army, encompassing individual training through total system training device and simulation requirements, and collective training measurement techniques. At the Department level, the Army in 1978 appointed a Director of Training, in DCSOPS with proponency responsibility for training in the Army. The Director of Training was not provided direct control of 6.1 - 6.4 funding - a responsibility of the DCSRDA. Nor has this new staff element appeared to have exercised training funds management through the Program and Budget process.

Research and Development funding guidance to the Army Development Command, DARCOM, is reflected in budget guidance and can be changed or modified at DARCOM subordinate command apportionment sessions or during the fiscal year, in order to pay for program shortfalls and laboratory inspired technology programs. Consequently, emphasis on improving the training technology base is limited in most laboratories.

As a consequence, the Army training "system" requires tuning, beginning with the Director of Training's direct intervention in the Program and Budget process (POM) in order to ensure R&D training funds are included for:

- Training Technology R&D for system and non-system devices/ simulators.
- Individual/unit training support.

The TRADOC commander establishes the requirements for the Army Training System. Therefore, he should have more impact on development and funding of the DARCOM training technology effort.

The DARCOM commander, consistent with DA DCSOPS guidance and TRADOC requirements, should ensure training base funds apportioned are adequate to the task and protected.

D. Navy Training System

The Chief of Education and Training for the Navy (CNET) is responsible for all initial introduction and basic skill training. Organizational charts notwithstanding, CNET has very little control over air training which falls under OP 05, little practical control over nuclear submarine training, and has no control over shipboard training. Further, since CNET is not a major claimant for R&D, it cannot be regarded either as the single focal point for training or for training technology.

Within the Navy there are two institutions that research and develop training technology. The first is the Naval Personnel Research and Development Center (NPRDC), which is part of the NAVMAT complex of Navy labs. The second is the Naval Training Equipment Center (NTEC), which is part of CNET, a separate major claimant reporting to CNO. NPRDC is more involved in people-related issues, while NTEC is more concerned with training material support, although the boundary between the two organizations is not sharply defined. It is interesting to note that NPRDC works for CNET but reports to NAVMAT, while NTEC works for NAVMAT and reports to CNET. Both NTEC and NPRDC attempt to provide a full spectrum program from 6.2 through 6.4, and attend to the need for the maturation of research into advanced development. They represent the only points within the Navy where such vertical integration is made. Their efforts to provide cohesive programs are frustrated by the parochial interests and fragmented authorities with the hierarchy above them. Indeed the only serious review in which relationships between program elements are questioned in knowledgeable detail is not in Navy at all but in OUSDRE (R&AT). It is difficult if not impossible for these two organizations to establish a meaningful, rounded program in the face of fractured and often ill-informed hierarchy. ASN(RE&S)'s lack of interest in the subject is reflected in the practice of leaving all program decisions to ASN(MRA&L.)

Within OPNAV there are five offices that claim to have authority over the program in varying degrees and subject areas. No single office, however, appears able to arbitrate. The informal result is that the warfare sponsors 02, 03, 05, have no real interest in 6.1/6.2/6.3

expenditures. They concentrate on 6.4 efforts, which are primarily prototype simulator acquisitions. ONR is responsible for 6.1 and coordinates informally with 01. Chief of Naval Technology, through NAVMAT, sponsors 6.2 efforts. The 6.3 activity is sponsored by OP 01, although OP 0987 seems to have a significant influence. However, both depend on the appropriate warfare sponsor to defend the program from cuts.

NAVMAT provides no guidance at the HQ level. MAT 07 has formal responsibility, but there is no longer a full time staff designated or cognizant of the subject. Sponsorship for 6.2/6.3 was deferred to NAVAIR. Neither NAVSEA nor NAVELEX has inputs into this part of the program. NAVAIR therefore establishes products for air, surface and sub-surface efforts. Sponsorship of 6.4 operates mainly through the respective warfare sponsors and the related SYSCOMS.

So long as each warfare element insists on approaching trainer acquisitions differently, cohesive action is impossible. Training material support for aviation is often submitted within the weapon system budget sponsor. Surface/subsurface trainers tend to have separate budget lines. Lack of coupling between training equipment and weapon system acquisition often leads to one being altered at the budget tables without corresponding modifications to the other's schedule.

Trainers are often delivered late. The lack of coupling of 6.2/6.3 with 6.4 and procurements tends to prevent 6.2/6.3 from being used to address risk issues. For surface/subsurface trainers, NTEC has early-planning visibility for 6.4 first-article acquisitions. Therefore, late starts and risk issues could be addressed by use of 6.2/6.3 if they were controlled. Risk reduction on the air side is aggravated by early planning data not being provided by NAVAIR to NTEC. This encourages decoupling of 6.2/6.3 from 6.4.

E. Air Force Training System

In spite of the early Air Force focus on training technology, a single proponent for training matters, including budget, program, and technology, is still essential, since 6.1 - 6.4 laboratory training technology efforts are not focused on future operational needs.

Within the Air Force, the difficulty in bringing technology to bear on training issues is first seen at the Deputy Chief of Staff level. The Deputy Chief of Staff for Manpower & Personnel (DCSMP) would appear to have philosophical differences of opinion with the Deputy Chief of Staff for Logistics & Engineering (DCSLE), which results in a differing definition of requirements through yet a third party, Deputy Chief of Staff for R&D (DCSRD). Neither DCSMP or DCSLE can claim to be "Mr. Training" although both are heavily involved in it. Neither controls training technology funds.

The Commander, Air Training Command (ATC), is responsible for undergraduate pilot, crew training, initial basic skills enlisted training, officer training, and Air University. The Commander, ATC is in a good position, therefore, to determine training technology requirements in ATC's area of responsibility. Yet, Commander, ATC must rely on a series of ATC Liaison Officers in the Air Force Systems Command (AFSC) to informally influence ATC's technology requirements. His formal channel for addressing training technology is in the Program and Budget process, where major commanders enter their command requirements into the POM. Unfortunately, operational considerations of the force normally outweigh the demands for training technology dollars.

The responsibility for R&D and systems acquisition rests with the Commander, Air Force Systems Command. Within AFSC, the Aeronautical Systems Division controls various aircraft weapon system program offices (SPOs) including one for simulators (SIMSPO). It is doubtful whether the Program and Budget process can focus effectively on 6.1 - 6.4 objectives in isolation from potential field requirements. To be answered is the question of how training R&D can be synchronized to ensure that training requirements of the future can be met by the laboratories.

For example, Air Force Office of Scientific Research controls 6.1 funding, whereas the Human Resources Laboratory (HRL) deals with 6.2/ 6.3 for training technology. Many different SPOs deal with 6.4 training technology funds (simulators), including several outside ASD.

F. U.S. Marine Corps

Within the Marine Corps, training technology responsibility is vested in the newly established DCS/Training. This office competes with other elements for R&D resources (6.2 - 6.4) provided through DCS/Research Development and Studies. While this provides a central focus within USMC for training technology resources, the amount is small (about 1% of the total R&D effort). The training technology R&D programs are managed by three Development Program Offices at the USMC Education and Development Command, Quantico. The R&D effort for training technology is performed at NTEC, Orlando and at NPRDC, San Diego. Therefore, it is believed that the USMC is structured to manage 6.2 - 6.4 training technology resources.

G. Summary of the Services Training Systems

An analysis of the situation across Services reveals some common features which, although not necessarily negative, provide a deeper understanding of the reasons why it has been difficult to focus technology on training issues. These include:

- Within all Services, training responsibility extends across several Deputy Chief of Staff positions.

- Execution of training cuts across many operational and training commands.

- Training technology funds are not held by any training component.

- Training technology execution is different for each Service, but the differences illustrate one facet of the problem: some labs report to the manpower side, while others report to the acquisition side. Training research presents the unique organizational dilemma of often being under acquisition but responding to personnel.

- The problem of bridging training issues with training technology extends to OSD.

It would seem, therefore, that the issue is not so much one of providing a Service spokesman for training, although many DSB members feel this is essential at the budget table. Rather, the issue is that to the extent no spokesman for training exists, he cannot aggressively "pull" technology or provide the necessary clout to defend training technology. Under the current organization, the various "special interest" spokesmen cannot effectively resist trainer acquisition costs without the involvement of the Service Chief himself.

This lack of proponency manifests itself in many ways. The expenditure of the DOD labs would not appear to reflect the significance of training or readiness; other than the single behaviorally-oriented lab in each Service, the labs do not regard training technology as being within their purview.

While specific Service laboratories are provided funding for training technology (AFHRL, ARI, NTEC and NPRDC) the other Service laboratories pay little attention to training technology; they do not regard such effort as within their charter. Thus, weapon and weapons system technologies developed by laboratories are devoid of effort to develop training systems to support those weapons systems. A view of the technology programs at the "hardware" laboratories discloses little if any effort in the training technology area, regardless of the funding (6.1, 6.2, 6.3, or 6.4). The reason for such neglect has been due in our opinion to the priority of scientific and engineering effort being applied to weapons development, and a corresponding lack of desire to participate in the less exciting areas of logistic support, including training technology.

The various laboratories are, however, a rich source of capability to manage the exploration of promising training technology areas. The current funding of Service laboratories is approximately $14B (FY82). We suggest, as an initial effort, $200M a year of the laboratory funding be directly applied to training technology. Further the Services should submit to OSD for overview the Service five-year plan to apply these funds to promising training technology. Over a five-year period, the application of $1B of technology-base funds could go far in developing new training technology for the military Services.

H. The Training Device Acquisition System

Historically, most training systems have been delivered later than the weapons systems for which they were designed. In some cases this delay is two years or more. The cost of this delay is estimated to be at least five percent of the total annual DoD expenditure for training. This estimate is based on readiness and proficiency loss, use of actual operational weapons systems for training, weapons system down-time caused by lack of training, and escalated cost of training devices caused by late ordering.

The basic reasons for these delays are:

- Late ordering of trainers, due to lack of engineering data.

- An overly complex acquisition system that requires milspec application and complicated procurement even for initial training devices.

The reluctance of industry to certify engineering data for training device procurement has been a problem for many years; however, the advent of Computer-Assisted Design (CAD) and Computer-Assisted Management (CAM) can substantially alleviate the problem by processing training equipment design requirements along with the basic weapons system design. Although there may have been a reason for the existence of engineering "reluctance" in the past, technology can now eliminate the excuse for not ordering training devices and simulators on time, so they may be delivered at least along with the weapons system. As regards the second point, procurement regulations are applied to training devices and simulators as though they were new procurement rather than an integral and essential part of a system acquisition buy. This means the application of the full spectrum of milspec and procurement regulations. This overload is sufficient to guarantee delay of training devices and simulation. The procurement lead time for a procurement over $5M is in excess of 300 days, assuming the availability of the required engineering data and all other elements required by the procurement system.

This restricts unduly the flexibility required in trainer and simulator acquisition. The extent to which many of these regulations can be waived to shorten the procurement leading for training devices is under study by the Army; the OSD acquisition executive should join in the effort and advise the Services to report to him the OSD actions required to modify the procurement system to shorten lead time for training devices and simulators. An example would be to ensure that the initial inventory of training devices be procured through the weapons systems prime while ensuring adequate subcontracting to the various training device and simulator manufacturers. This can be done by a class determination and funding coupled with sufficient incentives/penalties to ensure timely delivery.

The Director for Training and Education has, among his responsibilities, the function of manager for training resources and programs and acts as the proponent for the Services institutional and unit training programs. The focus is on management of Program 8-T dollars and the highly visible training programs specifically authorized by Congress. Improvements to training by the application of technology is monitored and encouraged, and new technology research and development is tracked by coordinating with the activities of USDRE and reviewing the work of the Service laboratories. The transfer of technology from laboratory output to training applications, however, is left to the Services.

Review of training plans for new systems is accomplished for selected systems in pre-DSARC briefings; comments on the plans are made to MRA&L for discussion at DSARC. No review of training or application of technology in design of new systems is made by MRA&L. Routine review of major simulation efforts is possible from R&D to procurement as part of the budget justification process.

Normal organizational lines exist for Training and Education to receive information through the Service Secretariats. There is also a panel called "Defense Education and Training Executive Committee (DETEC)," being formalized by a DoD Directive (Draft). That panel consists of the Principal Staff Director for Training for each of the Services, and the Director, Training and Education. Informal and formal coordination flows from the training commands, the Service staffs and across OSD Secretariats.

The Director, Training and Education, however, has only limited ability to change the training program of the Services or to influence the level of investment, because of restrictions within OSD for changes to the budget, POM process and the fact that the consolidated guidance assumes training under readiness.

Training and Training Technology is managed in the office of the USDRE by the Military Assistant for Training and Personnel Systems Technology. He reports to the USDRE through the Director of Environmental and Life Sciences and the Deputy Undersecretary for Research and Advanced Technology.

Responsibilities include:

- Provide oversight management for the Service's R&D (6.1 - 6.4) programs in training
- Represent the USDRE on all matters related to Training and Training Technology
- Provide informal liaison with the Director of Education and Training in MRA&L.

The budget for Training and Training Technology is divided into two categories (as recommended by Congress): (1) Education and Training (emphasis on curriculum development and schoolhouse training), and (2) Simulators and Training Devices (emphasis on flight, tank, ship and maintenance trainers.)

There is currently no direct way that USDRE can affect the Services' training technology programs in a positive way. USDRE does have authority to recommend reductions in funding; however, USDRE cannot reprogram monies to Service programs.

Currently, informal methods are used to maintain coordination between MRA&L and USDRE:

1. Annual laboratory apportionment and budget reviews (usually held in the field during May and July.)

2. Working with the American Defense Preparedness Association and the National Security Industrial Association to develop annual DoD/Industrial meetings on training and training technology.

3. To be initiated in FY 1983, MRA&L and USDRE will be publishing a joint report of selected Manpower, Personnel and Training accomplishments.

I. Status

There appears to be a disparity between the perceived contribution that training technology can make towards readiness, and the lack of attention given it at the budget table. This paradox resides in the dispersion of training and training technology responsibilities and their representation within DoD. **For example, there is little if any focus in OSD to provide adequate interaction between technological capabilities as seen by USDRE, and people/training issues as seen by MRA&L; training interests are not adequately addressed in the DSARC process; DARPA does not give priority to training technology.**

As for the Services, they resist the concept of a single manager-for-training-technology, and there are significant differences among them in the level of cohesive planning and focus applied to training needs. In every case the flow and management of 6.1 - 6.4 funds is fragmented and blurred. Other than the personnel-related labs (AFHRL, ARI and NPRDC), or the training technology R&D organizations (NTEC, PM TRADE), they do not see training technology to be within their purview. As a result, early, weapon-specific training research is inadequate.

Training devices are too often acquired too late to meet weapon system IOC, in some cases by as much as several years. The tardiness stems from delayed availability of certified weapon system data, the complexity of the acquisition process, and late initiation of the simulator funding line.

J. Issues and Recommendations

It is essential that the efforts of OSD be properly focused on training technology efforts to provide proponency for Services and JCS training initiatives. This will further provide the proper climate and definition for the training concerns. As an initial step, **this DSB panel recommends creating an executive steering group in OSD headed by USDRE and MRA&L. Additional members should include:**

- **OSD Comptroller**
- **JCS (J3)**
- **Secretariat**
  - **MP (MRA&L)**
  - **R&AT (USDRE)**

This steering group should accomplish the following:

- **Provide guidance and direction to DARPA through USDRE on training research needs.**

- Review training matters in the budget process and the training aspects of the Service POMs.

The effectiveness of the implementation of this recommendation **should be evaluated within two years. The action person for this recom-.** mendation is the Secretary of Defense. The five year cost is negligible

The apparent lack of proponency and focus for R&D efforts directed toward training technology also exists within the Services. While some Services are better organized to manage the 6.1 - 6.4 effort, training technology appears to receive equally low priority in all Services.

It is recommended that Secretary of Defense direct to the Services to develop a plan for a single focal point in each Service to respond to OSD decision requirements as well as to clarify the 6.1-6.4 funding flow and provide proper emphasis on training technology needs. The action persons for this recommendation are the Secretary of Defense and the Secretaries of the Services. The five-year cost is negligible.

Within the Service laboratories the setting of research and development priorities often does not include training technology. This may very well require changes in specific technical talents within the laboratory system and significant change in R&D priorities.

To stimulate the laboratory involvement in training technology issues, the Acquisition Executive should issue specific direction to the Services to provide five year R&D plans for the Service laboratories' participation in training technology research within their mission responsibility. The action persons for the recommendations are the Secretary of Defense and the Service Secretaries. The five year cost of the recommendations is $1B. The funds should come from reallocation of current dollars for 6.1-6.4 in the laboratory line of $14B.

For new training devices to be of greatest benefit to the weapon system they support, the training system should be in place at least by the time the weapon system is fielded. This is often not the case, with instances cited of the training device lagging weapon system IOC by years. These delays result in part from overly complex acquisition regulations and from the tendency to delay training device development until after the weapon system data matures. There are a number of ways in which the time and complexity of the acquisition system for training devices can be reduced. Because of the legalities involved in procurement, **it is recommended that Secretary of Defense convene an Ad Hoc committee of Service representatives chaired by USDRE to provide specific action within six months. The action persons are the Secretary of Defense and the Service Secretaries. The five year cost is a cost reduction of five percent of the annual DoD training costs.**

GLOSSARY OF ACRONYMS

AAW - Anti Air Warfare

ACFT - Aircraft

ACMI - Air Combat Maneuvering Instrumentation

ACT - American College Test

AF - Air Force

AFB - Air Force Base

AFHRD - Air Force Human Resources Development

AFHRL - Air Force Human Resources Laboratory

AFSC - Air Force Specialty Code

ASD - Aeronautical Systems Division

APN - Aviation Program/Navy

ARI - United States Army Research Institute

ARTBASS - Army Training Battle Simulation System

ARTEP - Army Training and Evaluation Program

ASNMRA&L - Assistant Secretary Navy (Manpower, Reserve Affairs & Logistics)

ANSRE&S - Assistant Secretary Navy Research, Engineering and Systems

ASUW - Antisurface Warfare

ASW - Anti-Submarine Warfare

ATC - Air Traffic Control

BITE - Built-in Test Equipment

BN - Battalion

C^2 - Command and Control

C^3 - Command, Control and Communication

C^3I - Command, Control and Communication Intelligence

CAD - Computer Assisted Design

CAI - Computer-Assisted Instruction

CAM - Computer-Assisted Management

CAP - Combat Air Patrol (Computer-Aided Programming)

CBI - Computer-Based Instruction

CDR - Commander

CEB - CNO Executive Board

CHNAVMAT - Chief of Naval Materiel

CINC - Commander-in-Chief

CMI - Computer-Managed Instruction

CNET - Chief of Education and Training for the Navy

CNO - Chief Naval Operations

COTR - Contracting Officers Technical Representative

CRT - Cathode Ray Tube

CTS - Communications Training System

DA - Department of the Army

DARPA - Defense Advanced Research Projects Agency

DCNO - Deputy Chief of Naval Operations

DCS - Data Collection System (Deputy Chief of Staff)

DCSLE - Deputy Chief of Staff for Logistics and Engineering (USAF)

DCSMP - Deputy Chief of Staff for Manpower and Personnel (USAF)

DCSRD - Deputy Chief of Staff for Research and Development (USAF)

DCSOPS - Deputy Chief of Staff Operations (Army)

DCSRDA - Deputy Chief of Staff for Research, Development and Acquisition

DDR&E - Deputy Director of Research and Engineering

DEP - Delayed Entry Program (Deputy)

DETEC - Defense Education and Training Executive Committee

DNET - Director of Naval Education and Training

DoD - Department of Defense

DOI - Director of Instruction

DON - Department of the Navy

DSARC - Defense Systems Acquisition Review Council

DSB - Defense Science Board

DTE - Development Test and Evaluation

ECM - Electronic Counter-Measures

EW - Electronic Warfare

FAA - Federal Aviation Agency

FEWSG - Fleet Electronic Warfare Service Group

FY - Fiscal Year

FYDP - Five-Year Defense Plan

GAO - Government Accounting Office

GPS - Global Positioning System

HARDMAN - Hardware Manpower

HI - Hit Indication

HQ TAC - Headquarters Tactical Air Command

HSDG - High School Degree Graduate

IFR - Instrument Flight Rules

IOC - Initial Operational Capability

ISD - Instructional Systems Development

JCS - Joint Chiefs of Staff

JPA - Job Performance Aid

LRG - Logistic Review Group

MAT - Materiel

MCA - Military Construction Authorization

MILES - Multiple Integrated Laser Engagement System

MOA - Memo of Agreement

MPRC - Multipurpose Range Complexes

MPT - Manpower/Personnel/Training
MRA&L - Manpower Reserve Affairs and Logistics
MSR - Mobile Sea Range
MTR - Military Training Routes

NAR - National Airspace Review
NAS - Naval Air Station
NAVAIR - Naval Air Systems Command
NAVELEX - Naval Electronics System Command
NAVMAT - Navy Materiel Command
NAVSEA - Navy Sea Systems Command
NCO - Noncommissioned Officer
NETP - New Equipment Training Package
NPRDC - Naval Personnel Research and Development Center
NTC - National Training Center
NTEC - Naval Training Equipment Center

O&M - Operations and Maintenance
OASD - Office of the Assistant Secretary of Defense
OBEWS - Onboard Electronic Warfare System
OJT - On-The-Job Training
ONR - Office of Naval Research
OPN - Operation
OPNAV - Naval Operations (CNO Officer)
OSD - Office of the Secretary of Defense
OTE - Operational Test and Evaluation
OUSDRE - Office of Under Secretary of Defense for Research and Engineering

PACAF - Pacific Air Force
PIA - Palmdale International Airport
POM - Program Objectives Memorandum

R&D - Research and Development

RAP - Remedial Action Program

RC - Reserve Component

RED FLAG - U.S. Air Force Air Combat Maneuvering Exercise

RTC - Regional Training Center

RDT&E - Research Development Test and Evaluation

RWR - Radar Warning Receiver

SAC - Strategic Air Command

SAT - Scholastic Aptitude Test

SCN - Specialty Code Number (Navy)

SECDEF - Secretary of Defense

SIGINT/EW - Signal Intelligence/Electronic Warfare

SIMSPO - Simulator System Program Office (AFSC/ASD/)

SPA - Skill Performance Aid

SPO - System Program Office

STINGER - (Hand-held Anti Aircraft Weapon) Army

STRAC - Standards in Training Commission

SUBAC - Submarine Advanced Combat System

SWAP - Severe Weather Avoidance Program

SYSCOMS - System Commands (Navy - Air, Electronic, Sea, etc.)

T&E - Test and Evaluation

TAF - Tactical Air Forces

TFWC - Tactical Fighter Weapons Center

TMPN - Training Materiels Procurement (Navy)

TRADOC - United States Army Training and Doctrine Command

UPT - Undergraduate Pilot Training

USA - United States Army

USAF - United States Air Force

USDRE - Under Secretary of Defense for Research and Engineering

USMC - United States Marine Corps

USN - United States Navy

VFR - Visual Flight Rules

VHSIC - Very High Speed Integrated Circuits

WPN - Weapon